Power and The Engineer

Vol. 32 NEW YORK, JULY 12, 1910 No. 28

A DISCARDED boiler, bought by a dealer in second-hand machinery, was recently offered for sale. The boiler had been exposed to the elements so long that flakes of rust could be loosened from the outside surface with a pocket knife. Many of the rear tube ends had been so burned and corroded that they were flush with the tube sheet.

This boiler was not repaired and then offered for sale, but was to be sold just as it stood.

Doubtless some one who has little regard for human life will purchase that boiler and put it into use without spending a dollar for repairs.

The worst of it is that the men who will be employed to care for such a boiler will not know of their danger. This increases the responsibility of those employing them.

When a man is accidentally killed, little is thought about the matter unless the circumstances surrounding the case are of such a nature as to attract the attention of the public.

When a fatal accident occurs, the Press publishes the facts with a head line something like, "Only one man killed."

If a tube in a boiler fails and some of the boiler-room attendants are scalded, the officials will state that it was nothing, only a few men scalded—nothing to speak of. And yet some of these men die within a day or two.

As an illustration that human life is valued cheaply in the commercial world we offer this:

Recently a railroad company was sued for damages resultant of an accident which happened because the trains were not protected by a block-signal system. The lawyer for the company showed in cold figures that it was cheaper for the road to settle damage claims and defend itself in law suits than to fit the tracks with a few semaphores.

Isn't it about time for engineers and others employed about the steam plant to recognize that they must safeguard themselves?

The excuse is often given that an accident was unavoidable, being beyond human power to prevent. Yet men connected with the operation of steam plants know that there are many plants scattered throughout the country which are operated under conditions far from safe.

It may be a steam pipe line, designed for 100 pounds pressure but carrying 150; it may be a bag on the fire sheet of a boiler; it may be that the tubes of a water-tube boiler are badly scaled because there has been no time in which to clean them; or it may be one of a hundred other conditions that cannot be remedied without the sanction of the company. Dangerous conditions should be remedied, for the sake of life if for no other reason.

If human life were considered at its proper value, such conditions would not be allowed to exist. If a man lost his life in an accident the matter would not be reported as, "only one man killed."

Refuse to work where conditions are needlessly dangerous. Become better qualified to determine when a dangerous state of affairs exists.

Clean Water for Condensing Purposes

By Warren O. Rogers

Originally the water was taken from a pond supplied by a small creek. In times of freshet the waters of the creek soon filled the pond with mud and debris. To avoid the frequent removal of this matter and to insure a clean supply of water, concrete walls were built to form a raceway for the main current and gate connection made with the pond to supply water as needed.

The available supply of condensing water is of considerable moment to engineers who run their plant condensing and the condition of the water has much to do with the successful operation of the plant.

In one instance recently noted, the water used for condensing purposes was obtained from a small creek running down from the hills of Tennessee. Along its banks were located slaughter houses, farm yards and manufacturing establishments. As a result, when the water reached a high stage various kinds of carcass, trees, shrubbery, leaves and other refuse almost too numerous to mention, floated down into the pond formed in the mill yard. The water used for condensing purposes was taken from this semi-circular shaped pond, through which the water of the creek rushed with considerable velocity, causing that portion of the pond not in the direct path of the current to fill up with mud and débris. The work of removing this accumulation after each heavy rain made the management of the mill look about for a means of relief, which was found by constructing concrete walls which divided the pond into three parts.

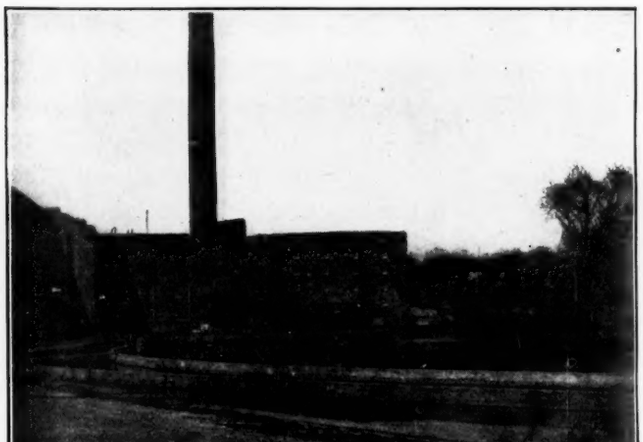


FIG. 1. POND AND RACEWAY

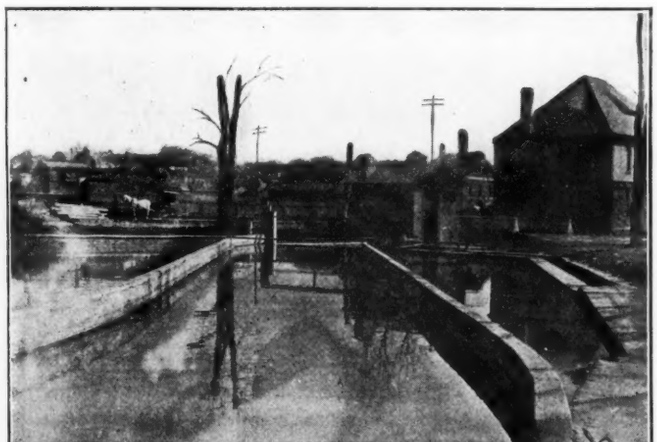


FIG. 2. NEAR VIEW OF RACEWAY

In Fig. 1 is shown a portion of the pond and the main raceway. Fig. 2 shows a portion of the other end of the pond. Fig. 3 shows a plan view of the entire pond and raceway.

The portion shown in the center of Fig. 2 and slightly in Fig. 1 is the raceway through which the water from the creek passes on its way to the mill yard. Through the winter months the water for condensing purposes can be taken from this raceway when necessary to clean out the reservoir without interfering with the condensing supply, but during the summer months when ten hours' supply from the creek is not sufficient for the condensers during the day, the water is taken from the large pond shown. By confining the water of the creek to the narrow channel of the raceway, the velocity of the current effectually cleans out any accumulation of débris that may come down from the hills, or dirt that may have accumulated during the lower stages of water, which in that vicinity is of a more or less muddy nature.

During the period of sufficient water the condensing water is allowed to run to waste through the narrow raceway *A* shown in Figs. 2 and 3, and over a small dam to the tailrace *B*. The pond *B*, located between the small and large raceways, is used as a reserve cooling pond. It is dammed at the lower end at the gate house, as are also the small and large raceways. The water in the large pond is controlled by gates. The small raceway and small pond are connected by the pipe *D*. At the upper and lower ends of the pond the large raceway and large pond are connected by wooden check valves, through which the flow of water is automatically controlled. This arrangement of valves will be explained later on.

In the summer months when the water is insufficient to provide for the day's run, the water flowing through the creek at night is held back by a dam constructed of boards, each section being movable so as to control the hight of the water at all times. The water held back flows through the gate *F* or *G*, Fig. 3, into the large pond, where it is stored for future use. In this manner enough water is obtained to supply the condensers during the next day's run.

The water from the condensers runs through the small raceway into the small pond and finally into the main raceway. By this arrangement the hot water from the condensers is obliged to heat the entire amount of water in the raceway *E* before it can even begin to heat the water in the large pond from which the condensing water is drawn.

When the water in the raceway *E* is heated, it must flow over into the large pond before it can transmit its heat to the water contained in it, and before the temperature of the water in the large pond is raised enough to interfere with its condensing properties the day's run is ended. By the next morning, the inflow from the creek and the effect of the night air has cooled the water in the pond sufficiently for another day's run.

Fig. 4 shows the device for controlling the gates regulating the flow of water between the raceway *E* and the large pond. It consists of a galvanized cylinder which extends down nearly to the bottom of the concrete wall. The water in the pond governs the operation of the float, which fits loosely in the galvanized

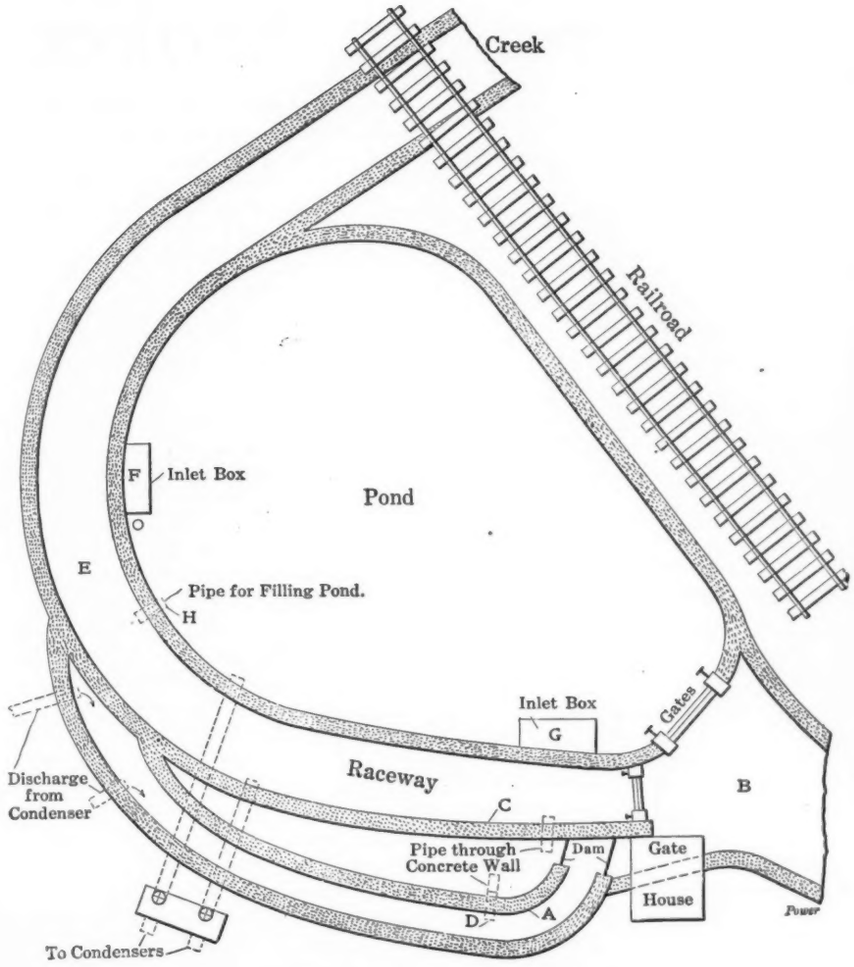


FIG. 3. PLAN OF POND, RACEWAY AND CONCRETE WORK

pipe, as shown. This float is lifted as the water rises, and in rising, lifts the lever *L*, Fig. 4, which is pivoted near the center at *A*. The attachment *B* is connected to an iron cross piece *C*, having a notch at each end. This cross piece engages with the two extension rods, which are secured to the gate rods by set screws. This device holds the gates open. The upper end of the rod *D*, connecting with the float ball, is arranged so that the maximum rise and fall of the ball can be controlled. The hight of the water which will cause the float to trip the gate is regulated by means of the adjusting holes in the float stem.

As the water in the pond rises to a certain predetermined hight, the float is forced up, lifting the cross piece *C* and releasing the extension levers *E* and *F* of the gate shaft. This allows the gates which shut off the water in the raceway from the pond to close by their own weight.

At first, leaves, grass and twigs getting into the gateway, caused considerable trouble, and it was found necessary to put in place the baffle plate *G* shown in Fig. 5. This baffle compels all water passing from the raceway to the pond to go down under it before passing through the passage in the concrete wall between the pond and raceway.

In case it is desired to empty the pond, the gates at the lower end are opened and the check gates *F* and *G* closed. If the water is at such a stage that it will not flow through the gate at the head of the pond, the funnel connection shown in Fig. 1 at the bend of the concrete wall and at *H* in Fig. 3 is lowered and the water allowed to flow from one side of the wall to the other. This pipe has a knuckle joint at the bottom and is fitted with an elbow at the top.

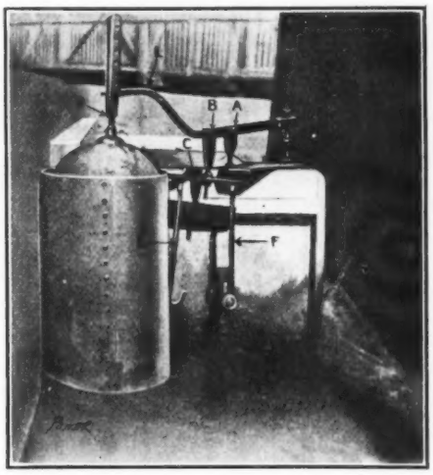


FIG. 4. FLOAT AND LEVER MECHANISM

The value of the entire arrangement is apparent. It furnishes a supply of clean condensing water in proper amount and at a temperature low enough to maintain a high vacuum during the running period.

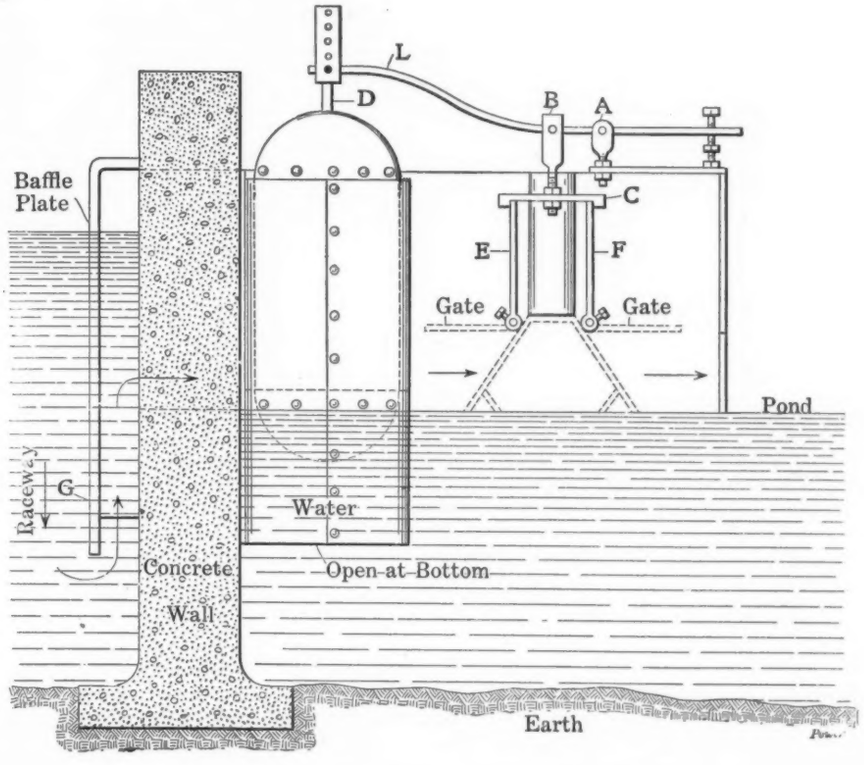


FIG. 5. DETAILS OF AUTOMATIC GATE

Front Feed Automatic Stokers

By J. F. Springer

Front feed stokers have grates inclined from front to back. Gravity and a slight movement given by mechanical means to the individual elements of which the grate is composed cause the fire and fuel to move downward at a uniform rate. These stokers are economical to operate and require relatively small floor area.

By borrowing a slang expression we may speak of gravitation as being "always on the job." Nothing can be done to material things which will affect gravitation. It exerts its influence upon all substances whether they be hot or cold. So it comes about that stoking machines which take advantage of gravitation secure thereby a valuable ally. One great difficulty in the automatic management of a furnace fire is experienced in keeping the grate well covered with fuel. In certain classes of stokers, the grate may become bare in places. This often results in damage to the exposed metal. In the front-overfeed stoker, this difficulty is overcome by tilting and agitating the grate surface. Any tendency to form a bare spot is promptly checked by the gravitation of coal from above. The side-overfeed stokers likewise possess this desirable characteristic.

It will be remembered, perhaps, that William Brunton obtained a British patent in 1822 which disclosed a form of stoker which consisted of tilted grate bars, whose motion, or the motion of one set of alternate rows of bars, combined with gravitation, had the effect of moving the fire *en masse*. At the rear, these bars slid back and forth on a fixed grate. All of these features are retained to the present day, but with important additions.

The present-day grate is made up of individual, tilted grate bars, but these are no longer merely strips of solid metal somewhat thinner between the ends. In Fig. 1 is shown in perspective one type of the modern grate section. It will be noticed that the section is of uniform width. A series of sections arranged side by side, allows but little space between the sections for a supply of air to enter. In fact, no reliance is put upon any supply obtained in this way. If the figure be examined closely, the face of each of the steps will be found to have a transverse slot. It is through these that air is supplied. But these slots do not communicate with the external air. The grate bars are hollow. This will be understood upon referring to Fig. 2. The upper end of each section is open. At this point is set a steam jet discharging into the bar. There is thus supplied a current of mingled air and steam which passes through the slots in the faces of the steps. The object of the steam jet is, primarily, to preserve the bars. This is a big problem for stoker manufacturers; how to give a reasonably long life to the bars, exposed as they are to the highly destructive furnace heat.

A view of the bars assembled is given in Fig. 3. It will be noticed that the sections are not flush with one another. The reason for this will be understood when attention is called to the fact that, as with Brunton's device perfected nearly 90 years ago, provision is made for their movement in sets composed of alternate bars. Further reference will be made to this later. At the present, attention is called to the ash table arranged horizontally at the feet of the bars. The coal which is, of course, fed in at the upper end of the grate surface, moves backward and downward under the combined influence of gravitation and the motion of the bars, burning as it moves. By the time it reaches the bottom of the grate surface it has become mostly ashes and clinkers. These, thrust back into the furnace more and more, fall over the firebrick curb onto the ash slide. This slide is arranged to permit the dumping of the refuse by being drawn forward, the rod for this purpose being plainly in view.

Referring to Fig. 2 it will be seen that after the coal is fed in at the hopper, its movement onto the grate surface is assisted by the pusher which slides back and forth on the upper horizontal surface formed by the tops of the grate bars. These bars are supported at their upper ends by a box called the wind saddle which extends across the front of the furnace. The bars communicate with this box through openings *A*. At their lower ends, the grate bars rest on a hollow bearer bar running across the furnace. The grate bars are moved back and forth as they rest on their transverse supports. To accomplish this movement, two hydraulic motors are installed with each stoker. In the upper right-hand corner of Fig. 2 will be seen a detail view of one of the motors together with the operating mechanism. The operation of the motors is effected by means of water supplied by a small pump and tank placed in the boiler room and constituting a part of the stoker equipment. There is a return line of piping, so that the same water is used over and over again. It is said that the steam required for operating the stoker amounts to no more than ½ to 1½ per cent. of the boiler output. The bars are heavy, weighing from 160 to 210 pounds each, varying with the installation. The steam used in the jets is thought to pay for itself in augmenting the heat of the furnace.

FIG. 1. A GRATE SECTION OF THE WILKINSON STOKER

In fact, the manufacturing company has made comparative tests, using an engine-driven blower in one case and a steam jet in another, and it was found that the evaporation per pound of coal was 9.22 pounds of water when the blower was used and 10.15 pounds when the steam jet was employed. The advantage secured by the use of the jet was, thus, nearly 10 per cent.

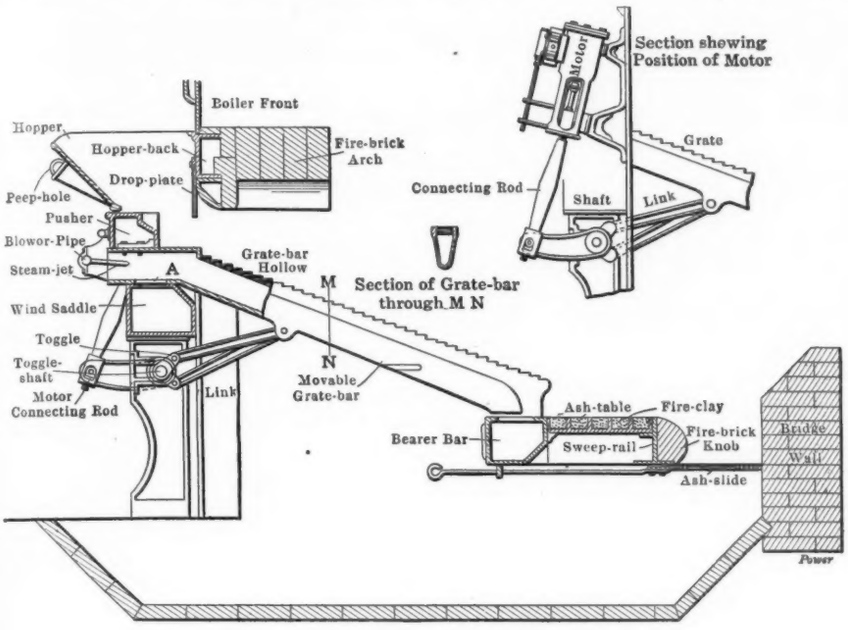


FIG. 2. DETAILS OF THE WILKINSON STOKER

One feature which is possessed by the front-feed stokers in common with the side-feed type, would seem to promise well for economic operation. In these styles of stoker the power required for the progressive feeding of the furnace is obtained largely from gravity. The coal, by its own weight, drops from point to point on the grate. Gravitation is not only "on the job" but involves no expense in its use. It is to be expected, then, that any stoker which, in whole or in part, is fed by gravity should show a marked economy in cost of operation.

Another type of front-feed stoker will now be considered. In general appearance the grate surface of this apparatus resembles a flight of steps with rounded upper edges. This will be understood by referring to Fig. 4. Here, as will be noticed, a portion has been cut away to show the construction more clearly. Each "step" may be considered as a grate bar. Each of these bars consists of a number of separate tops assembled upon a transverse supporting bar. It is only the upper edges of the tops which come into actual contact with the bed of incandescent coal. The tops used for the four upper bars of the grate have horizontal ledges on their sides. When the grate bar is completely assembled, there is presented an ordinary grate surface with longitudinal air slots. The depth of these slots affords a considerable cooling surface which tends to reduce the temperature of the grate. The horizontal ledges of the four upper bars are for the purpose of preventing the loss of fine coal while still permitting the ingress of air from below. When the coal has reached a lower portion of the grate, it is in a more or less consumed state and it is desirable that any ash coming in contact with the grate surface shall have opportunity to fall through. Hence, the style of the detachable tops is changed for the lower bars, as may be seen by referring to Fig. 4. Just above the uppermost grate bar there is a dead plate and upon this the coal is delivered from the hopper. Below the lowest grate bar are two perforated plates. The upper one of these is the guard grate. It may be raised by means of a rod to the position shown by dotted lines in Fig. 5. When thus raised, it prevents the bed of coals from slipping down. The guard grate is raised preliminary to operating the lower perforated plate. This latter is the dumping grate. It is hinged at a point back of its center and permits ashes and clinkers to be dumped in front or in back of the hinge. In Fig. 4 may be seen the rods which control the guard and the dumping grate.

The grate tops are interchangeable and can be readily removed or inserted. Inasmuch as the grate surface is not everywhere equally exposed to the heat, the wear of the upper surface of the tops varies with the position in the grate. However, the interchangeability of these parts makes it possible to redistribute them from time to time and thus equalize the wear.

A grate bar is provided at each end and below with a cylindrical bearing surface. The bars rest, by means of these surfaces, in suitable notches arranged in two inclined supports. The upper portion of one of these supports may be seen in Fig. 4. Each grate bar may be lifted into and out of its position as a unit. When in place, the character of its bearings permits a rocking motion of the bar. This rocking movement of the grate bars is desired largely for the purpose of assisting gravitation in progressively moving the fuel on and down. To provide this rocking movement is the object of

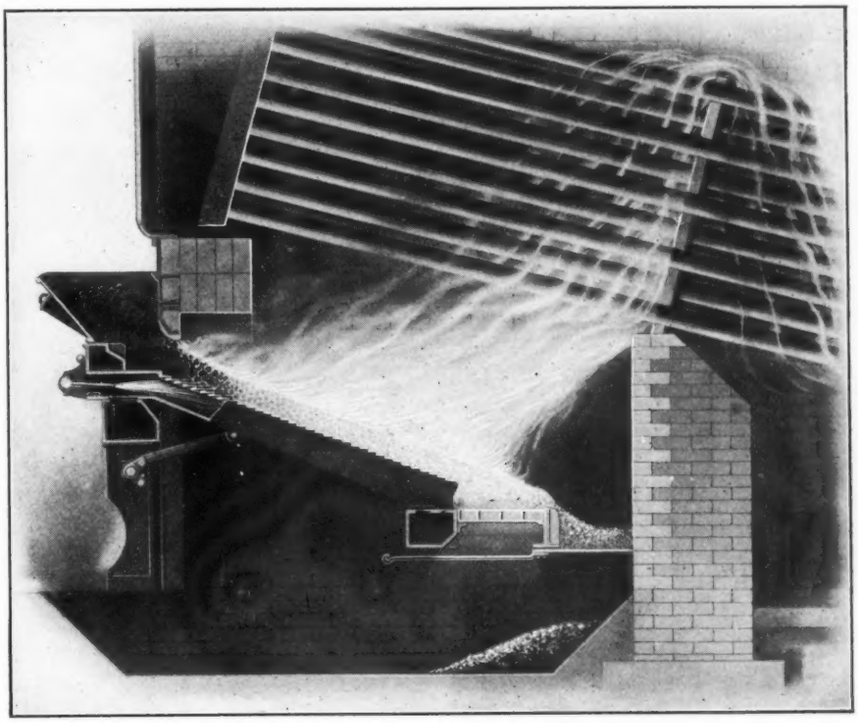


FIG. 3. SECTIONAL VIEW, SHOWING THE OPERATION OF THE WILKINSON STOKER

the application of power to the stoker. When a grate bar is lifted into its bearings, it is so balanced as to assume the normal position by its own weight. The rocking motion is accomplished by means of two arms which engage the lugs depending from the supporting arm of the grate bar. By means of suitable mechanism, these arms are moved back and forth and so cause the tops to rock. A portion of one of the rocking arms may be seen in Fig. 4. The cylindrical form of the surface which engages the lugs of the grate bar may, perhaps, be better seen in Fig. 5. The wear on the bearings of the grate bars is automatically taken up as it occurs by their weight.

FIG. 4. SECTIONAL VIEW OF THE RONEY STOKER

For establishing the amount of wear undergone by the tops, a test was made of eight samples taken from different parts of a grate surface below the line of the arch. These tops had been in service for seven months. The weight of a top, when new, is two pounds and fourteen ounces. It was found that the greatest loss of weight suffered by any top was eight ounces. Two lost five ounces each; two tops, four ounces each; one lost three ounces; one lost two ounces; and one top lost one ounce. The average loss was four ounces per top for a period of seven months. For a year, at the same rate, the loss would be nearly seven ounces per top. The life of the actual burning surface determines the life of the whole top. It has been calculated that the average loss in weight of the burning surfaces is about 17 per cent. per year. The operation of the grates, in the test just mentioned, was exceptionally severe. The fires were forced continually. At times the boiler developed a capacity 100 per cent. beyond its rating. It is reasonable to expect that the detachable tops of this stoker need replacement but once in six years. To secure this result, however, it is necessary to redistribute the tops from time to time.

The mechanism controlling the rocking movement may be seen in Figs. 4 and 5. It will readily be granted if the mechanical construction is considered, that the power required for operating the mechanism is small. The grate bars themselves are well balanced so that the power is mainly expended on the actual movement of the fire and the friction of the bearings. Gravitation assists materially in the onward movement of the fire.

The furnace in which a stoker of this type is installed should fulfil certain conditions. A low arch should extend across the mouth of the furnace. There should be a baffle wall above this arch for the purpose of causing a current of air, admitted from the front of the furnace, to circulate over the top of the arch, and then to find an exit into the furnace at the front. This will be better understood by referring to Fig 6. The poker door may be seen at the lower left-hand corner. In Fig. 4 underneath the arch, may be seen the opening in the front wall covered by this door. Above this poker door, Fig. 6, is shown the wind gate. This is for the purpose of admitting air above the arch. The air passes in and back to about one-half the depth of the arch. The arrows show the path which the air follows, first back and then to the front, where it is directed downward and finds its way into the combustion chamber just under the front of the arch. It will

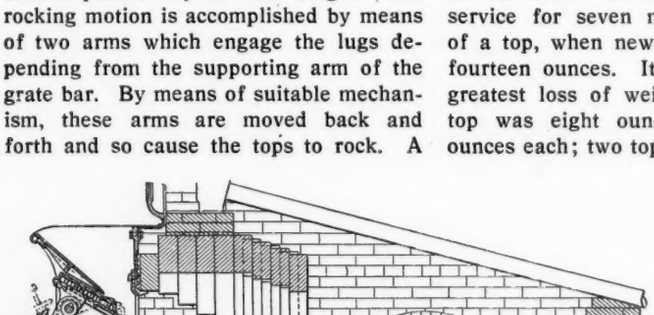


FIG. 5. DETAILS OF RONEY STOKER

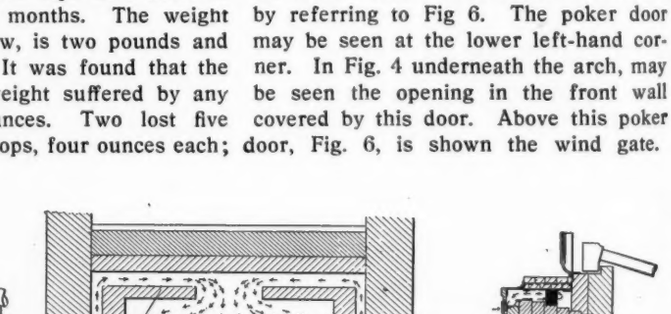


FIG. 6. DETAILS OF ARCH AND BAFFLE WALL

be noticed in Fig. 6 that there are two wind gates, supplying the air from both sides, and that there is a symmetrical arrangement of the baffle wall. The fuel is fed in from the hopper onto the dead plate. The coal is supplied with no circulation of air through its mass. However, it is subjected to the heat of the contiguous fire, reinforced by that of the combustion arch. A process of distillation takes place and the volatile hydrocarbons rise from the surface. The air coming down through the nozzles from the hot chamber above is mingled with these gases and the whole is directed downward and to the rear by the contour of the arch. This arrangement would seem to favor complete combustion. The oxygen necessary for the production of CO_2 and H_2O from the hydrocarbons is not only supplied but it is supplied in a heated form. Moreover, the many nozzles distribute the supply well. The arch tends to promote combustion in that it maintains a high temperature itself and directs the mixed hydrocarbons and air into the hot part of the combustion chamber. It will be remembered that the first four grate bars are provided with non-sifting tops; in other words, provision is made to meet the possibility that there may be some coal on the first four bars that has scarcely begun to be consumed. However, there is a supply of air from below, the arrangement of the horizontal sifting ledges permitting this. That is to say, the design of the stoker contemplates that more or less coking may be going on until the fuel has dropped onto the fifth grate bar. The rocking motion of the bars, which is always going on slowly, results in the progress of the fuel down the stepped surface of the grate. As the bars rock back and forth there is a change in the amount of air supplied from below. The amount of this variation is about one-third of the air supply at its maximum.

By referring to Fig. 6 it will be noticed that the air coming forward from the rear of the baffle walls does so over the center of the arch. Other things being equal, one would expect that it would rush straight forward to the central nozzles. This would have a tendency to oversupply the center of the mass of hydrocarbons rising from the coking fuel and to undersupply the sides. However, by studying the figures, it will be seen that the space between the roof and the arch is increased toward the sides. This has the effect of equalizing the distribution of the hot air to the nozzles. The tendency of the air to rush straight forward tends to produce a congestion which reacts in forcing air into the freer side spaces.

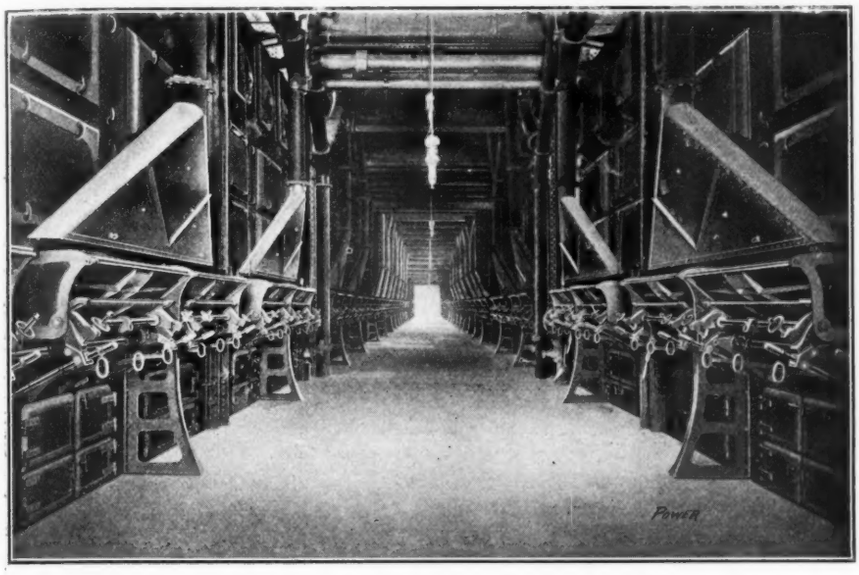


FIG. 7. INSTALLATION OF RONEY STOKERS

That this stoker and furnace are competent to produce a smokeless combustion of the hydrocarbons is well shown by the observation made by the Cleveland, Ohio, authorities of the combustion obtained by the Cleveland Illuminating Company. The combustion beneath the boilers supplied with these stokers, although they were being operated above their rated capacity continuously, was determined to be 99 per cent. perfect.

In Fig. 7 is shown a large installation of these stokers at the plant of the Interborough Rapid Transit Company, New York City. The total boiler capacity of the entire plant is about 37,500 horsepower.

Stokers of this general type have been in use for the past 25 years. It is said that in this time machines having an aggregate boiler-horsepower capacity of 1,250,000 have been installed. From this it will be gathered that it is by no means an untried apparatus.

Another type of front-feed stoker is shown in the sectional view in Fig. 8. The position of the arch and the wall at the inner end of the fire chamber is shown. The grate is inclined at an angle of about 40 degrees. It is made up of detachable bars. These are practically smooth on one side and have ribs on the other. In the figure the ribbed side is shown. The upper ribs are but slightly inclined to the horizontal. In fact, what dip there is, is directed inward. The ribs below incline steeply to the front and provide between them ready exits for ash. The horizontal character of the upper ribs is for the purpose of preventing unconsolidated fine coal from sifting through but at the same time permitting an adequate supply of air to pass into

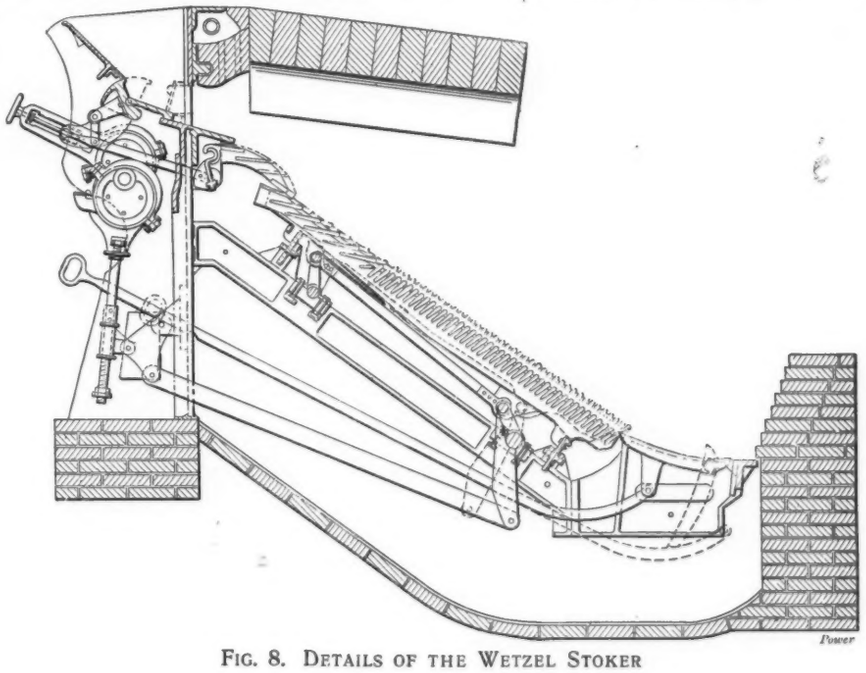


FIG. 8. DETAILS OF THE WETZEL STOKER

the furnace. Above the grate proper is the coking shelf where the air supply from below is either almost entirely or wholly cut off. This consists, in the main, of a movable and sharply inclined surface. Above this is a stationary shelf having a moderate dip. This may be regarded as really a part of the feeding hopper. Above, and to the left, the bottom of the hopper consists of two surfaces linked together and capable of a back and forth movement. When moved toward the rear of the furnace, the one straightens up and executes a considerable thrust, forcing the coal onward. The other surface moves on somewhat, sliding on the fixed shelf. A study of the link arrangement connected with the movable bottom will show that a rod goes off to the rear to operate the movable part of the coking shelf.

The arrangement is such that both movements are simultaneously accomplished. The amount of this movement is controlled by a screw seen on the left. The movement itself is secured by means of an eccentric arrangement of which the screw forms a part. This device is partly hidden in the view.

Another eccentric is to be seen in front. These eccentrics are oppositely placed but operated by the same shaft. The length of the rod of the latter eccentric is regulated by a lock nut as shown. By means of a link arrangement, pivoted to a fixed pin secured to a lug on the face of the furnace, the entire device is operated by the eccentric to produce a slow shaking movement of the grate. The dumping of the ash grate is effected by the hand rod running the length of the stoker.

A notable installation of this type of stoker is that in the power plant and water works at Tacony, Philadelphia, Penn. There are six boilers of 500 horse-power each. These are arranged in pairs, the members of the pairs being connected by underground flues. The hot gases are guided alternately upward and downward by three transverse plates with the result that they leave the boiler flowing downward by an underground flue.

In Fig. 9 is a perspective view of this installation. A small engine supplies the power. The enormous speed reduction necessary is accomplished by a worm-and-gear arrangement inclosed in a cast-iron housing. The view of the first boiler shows the handwheel which controls the link movement connected with the hopper bottom and part of the coking shelf. The eccentric which operates the grate movements may be plainly seen at the right-hand side of each hopper in the photograph.

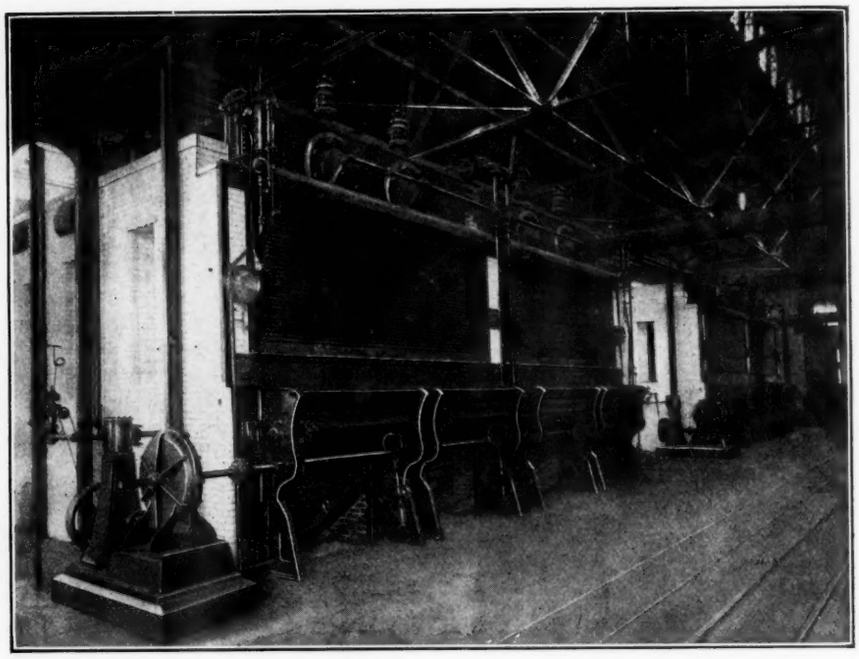


FIG. 9. INSTALLATION OF WETZEL STOKERS

Purchasing Oil By Specification

By Alfred Williamson

Lubricating oil is difficult to purchase on specification because its lubricating qualities cannot easily be measured. The Department of Water Supply of New York City purposes to contract for its lubrication on a basis of foot-gallons of water pumped.

Few contributions on the subject of lubrication come from the purchaser; the majority deal with the matter from the viewpoint of the ultimate consumer, or of the laboratory investigator. There are, doubtless, many cases of central-office supervision of a number of isolated plants, in which all supplies are purchased and repairs and renewals are directed by an engineer who never actually sees the materials or work ordered by him.

The City of New York is bound by its charter publicly to open bids on all expenditures in excess of $1000. Thus, in the matter of lubricants it is necessary that an annual estimate of the consumption be prepared, and if the total exceeds the limit imposed, specifications must be prepared and a contract awarded to the lowest bidder.

A further provision in the charter prohibits the specific mention of trade or brand names unless the destructive clause "or equal thereto" be added. If the engineer wants Jones' oil, for instance, which he knows to be a good brand, he must call for "Jones' A No. 1 brand, or equal thereto" and it will be his duty to prove that a cheaper grade submitted by Smith is *not* equal thereto.

Packing, oil and coal are the most troublesome commodities which any engineer is called upon to consider. Private consumers, however, who can purchase the two first by brand names and get what they wish or expect, are absolutely care-free in comparison to the municipal engineer who is hampered by the limitations mentioned. The coal problem is common to all, but the B.t.u. basis of purchase is expected to solve it.

In purchasing oil, the procedure followed by the Department of Water Supply, Gas and Electricity is typical of the method employed in all of the city departments. A standard form of supply contract is employed, the embodied specifications meeting with annual alterations as experience accumulates. Hitherto it has been customary to state that the oil must be one of a number of stated brands, *or equal thereto,* and to require that a sample be submitted with the bid. The list of brands was followed by a carefully considered schedule of physical properties, approved by the department chemist, and based upon what really good oils it had been the good fortune of the engineer to procure. A further clause, weakly clamoring for a good lubricant, was added as a last wish.

The results have been unsatisfactory, due to the difficulty of writing an iron-clad specification; for it is well known that the measurable qualities of a lubricant can be closely approximated in any viscous compound, even molasses, the one quality, namely, *lubrication*, being practically indeterminate. Low bids have always been accepted and although, in certain cases, fair oil (at the price) was furnished, it has never been possible to arouse the interest of the producers of the higher grades whose brands were specified.

The last specification prepared set forth the following physical requirements:

"Cylinder oil must be a high-grade mineral oil, steam refined, containing not less than 6 per cent. of acidless tallow oil. The mixture must be absolutely free from resinous or insoluble matter, and it must conform with the following requirements:

"Baumé gravity at 60 degrees Fahrenheit, not more than 26 degrees. Flash point, not lower than 580 degrees Fahrenheit. Burning point, not lower than 650 degrees Fahrenheit. Viscosity at 210 degrees Fahrenheit, not less than 175 Tagliabue. Acid, not more than 0.25 of 1 per cent.

"Engine oil must be a high-grade mineral oil containing not more than 6 per cent. of animal or vegetable oil. The mixture must be absolutely free from resinous or insoluble matter and it must conform with the following requirements:

"Baumé gravity at 60 degrees Fahrenheit, not more than 29 degrees. Flash point, not lower than 420 degrees Fahrenheit. Burning point, not lower than 480 degrees Fahrenheit. Viscosity at 70 degrees Fahrenheit, not less than 450 Tagliabue. Acid, not more than 0.25 of 1 per cent."

In place of the list of standard brands the following was inserted:

"In addition to the requirements above specified, all oil must possess satisfactory lubricating quality and the quality must remain uniform throughout the term of this contract. The lubricating quality will be manifested in the operation of the pumping engines and smooth, silent and economical operation must be maintained with minimum quantities of oil. The minimum quantities have been set by previous consumption and any oil furnished under this contract which for ten consecutive days necessitates increased consumption over the daily average for the previous six months, at any pumping station, will be rejected."

Prior to the preparation of this contract a satisfactory brand of oil had been purchased in the open market pending the public opening of bids, and it was on the consumption of this oil that the above standard was established. The present contract has not been in operation long enough to permit of a thorough judgment of the consumption clause, but this clause is believed to be of greater value as a specification than any enumeration of physical limits, brand names, or other requirements.

A form of contract is now considered whereby lubricants will be paid for on the basis of the work done in the plants; the unit on which payment is to be based will be the gallon-foot of water pumped instead of the gallon of oil as heretofore. On this basis it is believed that the contractor will find it more economical to furnish higher grades of oil because the total cost to him, per unit of work done, will be less than it would be if a larger amount of low-grade lubricant were consumed.

Economical lubrication, without corrosive or abrasive detriments, is sought, and lubrication cannot be better determined than in the engine room. As a standard of economical lubrication, satisfactory consumption may reasonably be set. Lubrication without good economy and parsimony without good lubrication are the limits of consideration; the mean is satisfaction.

An Unexpected Power Factor

By Charles C. Klein

Looms on two floors were driven by shafting located on the ceiling of the lower floor. The tension in the upper belts had offset that in the lower ones. The removal of upper looms resulted in a disproportionate increase in the friction load. The cause of this, until conditions were closely studied, baffled detection.

In the adjustment of differences between those who buy and those who sell mechanical power the consulting engineer often meets perplexing difficulties. Not only do the textbooks, upon which he bases his calculations, seem to ignore and omit important data, but his own practical experience appears, at times, valueless in aiding him to solve the problems which confront him. He is engaged primarily to guard the interests of his client, but in doing this he must always refrain from doing any injustice to opposing interests. Quite unexpectedly he may be called upon to settle very unpleasant and perplexing difficulties, as the following incidents will show.

Two large rooms, each 53x202 feet in size, in a mill in which the writer had charge of the power plant, were rented to a party having 480 power looms, of which 240 were on the second and 240 on the third floor.

Numerous engine tests have established the fact that one horsepower is ample to drive eight of these looms. The system of power transmission is shown in Figs. 1 and 2, in which the dotted lines on the half plan represent belts. The shafting was hung underneath the third floor.

A main line shaft, capable of carrying fully 80 horsepower, was located close to and parallel with one of the longitudinal walls. Three cross-counter line shafts, receiving their power from the main line through 30-inch mortise-miter gears, served to distribute the power through the rooms.

The looms were placed in three double rows, running from one end of the mill to the other. The arrangement is indicated at the left of Fig. 1, the small circle representing the position of the operator of four looms. Each bank of eight looms was provided with a countershaft $1\frac{11}{16}$ inches by 6 feet, 4 inches, which drove four looms on the third floor and four on the second, the belts for the upper four looms passing through holes in the third floor, as indicated in Fig. 2.

Monthly tests showed that 75 horsepower was the average total consumption of power of the two rooms, the working load keeping remarkably close to 60 horsepower, which was charged to the tenant at $50 per horsepower per year. The friction load of 15 horsepower was charged to the account of the landlord.

The average power consumed was slightly less in the summer months than during the cold-weather months. The tests always showed a slightly greater consumption of power during Monday forenoon.

In the course of time conditions arose which made the removal of all of the looms from the third floor necessary. The first intimation, after the removal, that something was wrong, came to the engineer in the form of a much smaller reduction in the consumption of coal than was commensurate with the amount of machinery that had been removed. If the former power amounted to 60 plus 15 horsepower, or 75 horsepower, the amount after the removal should have been 30 plus 15 horsepower, or 45 horse-

power, under the most unfavorable conditions. For a decrease of 30 horsepower there should have been a proportionate decrease in the consumption of coal to the amount of about half a ton per day. Instead of this the amount saved was less than a ton a week. It was quite natural to attribute this meager saving in coal to increased friction caused by the shafting being thrown out of level by the removal of the 240 looms from the third floor to which the shafting was hung, the looms aggregating a total weight of over 100 tons.

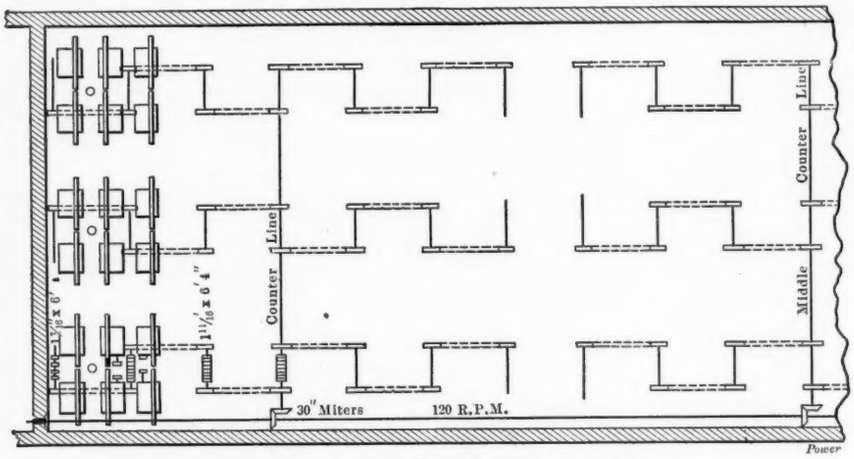


FIG. 1. PLAN SHOWING ARRANGEMENT OF SHAFTING

As a first step in the settling of the question the engine was indicated for the total load and then for the friction load. The first diagrams taken were immediately computed and showed a total load of 65 horsepower and a friction load of 30 horsepower, leaving, thus, 35 horsepower consumed by the 240 looms, as the working load. Here was an increase in the consumption of power of five horsepower for the looms and 15 horsepower, or 100 per cent., in the transmission.

A force of men were set to work leveling up the shafting and examining all the hangers to make sure that the bearings were free and that the lubrication was good. As no glaring defects were discovered, the puzzle became greater as the work proceeded. The loom fixers were told that they must look carefully over every loom, that none of them must be "overpicked" and that at the next test every loom must be in first-class working condition. Another test was made with the following average results: Working load, 31 horsepower; friction load, 27 horsepower; total, 58 horsepower.

A slight gain over previous conditions had been made, but as everything had been done that possibly could be done, the consulting engineer went home very much disappointed, if not discouraged, determined, however, that he would solve the problem. He was familiar with every detail of the power plant and the transmission of the mill, having full detail drawings of every belt, gear, shaft, coupling and hanger and their relative positions. He lost no time in looking over all of the drawings appertaining to the transmissions for the two rooms. As all of the trouble had been caused by the removal of the looms from the upper floor the solution of the problem had evidently to be sought for in this change.

The mere removal of the weight had had no effect or only a very slight one in disturbing the level of the shafting, for the mill was very substantially built with 12x18-inch yellow-pine girders, 10 feet from center to center. Hence, the cause of the trouble had to be sought in a primary effect which had been produced by the removal of the looms from the upper floor.

After a prolonged search among the blueprints and a great amount of thinking, he picked up a drawing which is represented by Fig. 2. No arrows were shown on it. He sketched them in with his pencil and a flood of mental light seemed to emanate at once from that drawing. The pulling sides of the belts for the upper looms were on the opposite sides of the pulleys from those for the lower looms and they pulled in opposite directions, thus balancing the strain. What would have been the effect if the upper-loom belts had been put on before those of the lower ones? He made a rough calculation thus: There were 240 two-inch belts, each one having a tension of 60 pounds, which would have a tendency to lift the weight of the shafting and transfer the weight to the small shafts of the looms and as

$$60 \times 240 = 14{,}400$$

pounds, there would be that much less weight to produce friction in the transmissions. Some of this counterbalancing effect would, no doubt, remain after the belts for the lower looms were put on. Not only this tension, but also the driving strain of 60 pounds for every loom on the lower floor balanced by the same amount of driving strain for every upper loom, was what had been relied upon to produce a minimum of friction.

Under these circumstances, strenuous efforts were made to find a new tenant. In the course of a few months one was found who was willing to use the third floor as a weave room and to have his beaming, bobbin-winding and other auxiliary work done outside.

The looms were delivered in instalments of about 40 each and as it was dangerous to introduce the new belts through the belt holes in the upper floor, dangling among the running belts and pulleys underneath the floor, it was decided to put the new belts on at night when the engine was stopped. The engineer was very particular to have all of the belts for the lower looms thrown off before those for the upper looms were put on, and all of the new belting had to be guaranteed to be fully stretched.

After the first instalment of 40 looms had been running about a week a test was made and, as was anticipated, it showed an average reduction of 2.5 horsepower in the friction load. The engine tests were performed regularly as each succeeding instalment of looms was put into service and in each test a regular proportionate decrease in the friction load kept pace with the uniform increase of the working load.

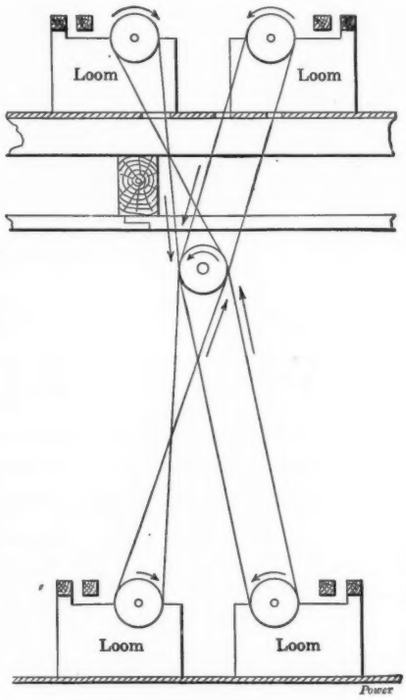


FIG. 2. VERTICAL SECTION

About a month after the last instalment was in full working order the indicator diagrams averaged precisely what they had before the removal of the original looms from the third floor.

The electric-lighting system at Fort Rosencranz, which is located near San Diego, Cal., has been connected with the transmission lines of the San Diego Consolidated Gas and Electric Company for service.

A Peculiar Case of Wear

Peculiar cases of wear come to notice occasionally, which are more or less interesting. Fig. 1 shows a case which to all appearances is an ordinary ring made from round brass stock and an oblong piece of metal. Originally, however, the ring was a locknut and the oblong piece an adjusting bolt used in the type of piston shown in Fig. 2.

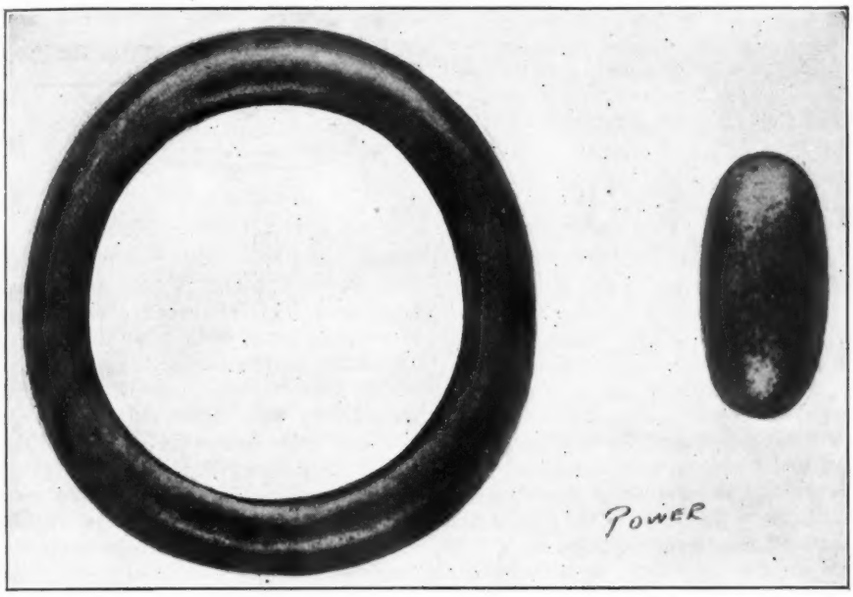


FIG. 1. WORN NUT AND STUD

In this design of piston, the ring was originally set out and the piston centered by means of the bolts *A A*, the studs bearing against the springs *B B*. The studs and nuts, however, had long been out of commission, as the condition of the one shown in Fig. 1 is evidence that it had long passed the point of usefulness. The stud was originally 5/8 inch in diameter, the illustration showing the worn portions enlarged to four times their original size. The piston was apparently leaking steam, and upon being overhauled it was found that some of the locknuts and studs had disappeared entirely, and one was found worn to the shape shown, by the constant working inside of the piston.

The engineer, who had run the engine for years, believed in letting things alone as long as the engine would turn, so the piston had never been examined until the excessive leakage of steam passing by the piston ring made it absolutely necessary.

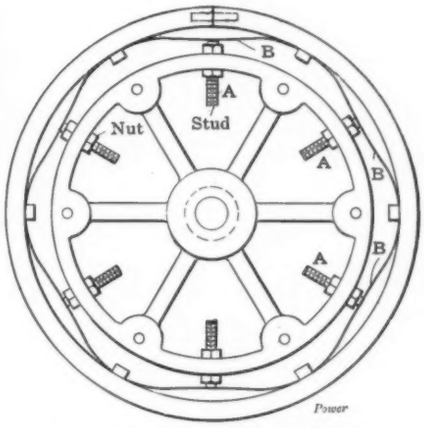


FIG. 2. SHOWING TYPE OF PISTON

Uncle Pegleg's Philosophy

Uncle Pegleg explains why a jet has eight times the energy when it runs twice as fast, also why an impact turbine must run at one-half the velocity of the jet to get the energy all out of it; but I get him stuck when he tries to explain that a reaction turbine must run as fast as the jet.

When the edge had been taken off of our appetites the next day, Uncle Pegleg pulled out a sketch like Fig. 1.

"Suppose," he said, "that the pump was running just fast enough to keep the water level steady while the hose is pulling it out. Then the pump is pumping as much water as the hose is delivering, and against the head *h*, which we will say is 100 feet. Now what would happen if you doubled the speed of the pump?"

"The tank would run over," I said.

"Sure, because the hose is taking out all it can *under that* 100-*foot head*. But say, that's what you wanted to do yesterday without increasing the head at all."

"We wasn't talking about heads yesterday," I retorted.

"I told you a stream would have eight times the energy in it if you doubled its velocity, and you said it would have only twice as much because the same pump would pump it running twice as fast. The fact is that to get twice as much water a second out of that hose you have to have a whole lot more pressure behind it. Your pump has not only to run twice as fast but to pump against four times the pressure, and this is what makes

$$2 \times 4 = 8$$

times the power.

"Now I want," continued the old man, "to prove to you, or to make you prove to yourself, that that four times the pressure is so. You understand the formula we worked out yesterday

$$E = \frac{W v^2}{2g}$$

and allow that it is all right, don't you?"

I agreed to it.

"And you agree that energy is weight × hight, don't you? If you lift 10 pounds, 4 feet you do

$$10 \times 4 = 40$$

foot-pounds of work."

I admitted that too, and he went on:

"Two things that are equal to a third must be equal to each other. If

$$E = wh \text{ and } E = \frac{Wv^2}{2g}$$

then

$$wh = \frac{Wv^2}{2g}$$

"If two things are equal," he went on, "and you take the same quantity away from each of them, the remainders will still be equal. The weight is in the quantities on both sides of the equal mark as a multiplier. Take it out of both and you have

$$h = \frac{v2}{2g}$$

meaning that the hight of column or head h necessary to get up a velocity v is equal to the square of that velocity divided by $2 \times g$, and g, you remember, was about 32 feet per second. Now multiply both sides of the equation by $2g$."

I worked it out like this:

$$h \times 2g = \frac{v2 \times 2g}{2g} = 2gh = v^2$$

"Good!" said the old man. "After you have done it times enough you will find that all you have to do to change quantities from one side of an equation to the other is to make them multipliers if they have been dividers, or dividers if they have been multipliers."

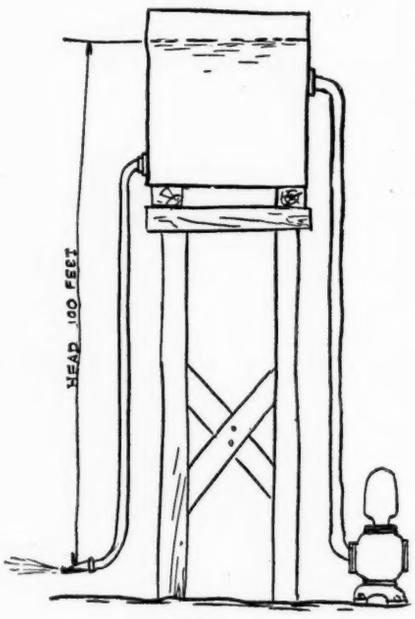


FIG. 1

That one trick has been of more use to me than almost anything else that the old man told me, and I want to devote a chapter later to showing how helpful it is.

"Suppose you had a head of 100 feet, what velocity would you get?" he asked. "Do it with that formula you just got and call g 32 feet per second."

I put the figures which I knew, 100 for h and 32 for g, in the place of the letters, and got

$$V^2 = 2 \times 32 \times 100$$
$$v^2 = 6400$$

"Then," said the old man, "the velocity must be 80 feet per second, because

$$80^2 \text{ or } 80 \times 80 = 6400$$

and

$$80^2 = 2 \times 32 \times 100$$
$$v^2 = 2 \times g \times h$$

Now suppose you wanted to double that velocity; what head would you have to have? Call $2g = 64$. Your doubled velocity will be

$$2 \times 80 = 160$$

feet per second. Then going back to the formula before you transposed it you have

$$h = \frac{v^2}{2g} = h = \frac{160^2}{64} = \frac{160 \times 160}{64} = 400 \text{ feet}$$

You see that to double the velocity you have to have four times the head. You can see that at a glance by your formula which says that the head equals the *square* of the velocity divided by a constant number, so that if the velocity has been 1 and you want to make it 2 the head becomes $2^2 = 4$. Am I right?"

I looked it all over and concluded that I didn't have Uncle Pegleg in so tight a corner as I had thought.

"How hard would it hit a man?" I asked, thinking back to the fire stream and its velocity which had started the discussion.

"Well, that's harder to figure," replied Uncle Pegleg. "All the energy that's stored up in the stream will be given up when it's brought to rest. I've showed you how to figure the energy stored up in it, the energy it takes to get it to going. If you can tell how completely the man takes the motion out of it you can get the energy it spends on him, and if you know how far he yields under the impact you can get the force end of the energy. You see the jet must be brought back to rest before it will give up all the energy it took to get it into motion, just as a raised weight must be let back to the starting level before it will give up all the energy it took to raise it. Take one of those impulse waterwheels with a jet playing on a bucket like this, Fig. 2.

"Suppose the jet was moving 1000 feet per second and that the wheel was standing still. Then if there was no loss by impact and friction, the water would be simply turned around and would travel backward as fast as it came. It would have lost no velocity, have given up none of its energy and done no work. Suppose the bucket to be going as fast as the jet; then the jet certainly wouldn't lose any velocity on it. The head of the jet would be touching it all the time, going with its original speed, and the rest of the water would never get to it. But suppose the bucket to be going at 500 feet per second, half the speed of the jet. Then the water would hit the bucket with a

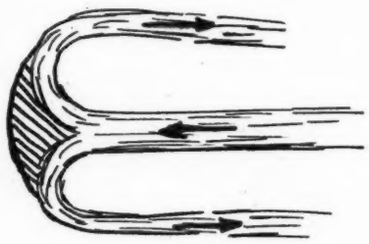


FIG. 2

velocity of 1000 — 500 feet per second, 1000 because the jet is traveling at that speed and less 500 because the bucket is running away from it at that speed. The water hitting the bucket at a speed of 500 feet per second would be turned around and shot backward from it at 500 feet per second relatively to the bucket; but since the bucket is going forward at a speed of 500 feet and shoots the water backward at a speed of 500 feet per second measured from itself the water will be motionless with reference to the ground and will fall dead off of the wheel. The forward motion of 500 feet per second which it shares with the bucket will balance the backward motion of 500 feet with which it is thrown off of the bucket.

"So you see in a wheel of this kind or in a turbine the wheel must run at one-half the velocity of the jet or stream which plays on it to get all the motion and energy out of it; a little less actually on account of friction and direction if the water doesn't come and leave straight on.

"It is different if the wheel is pushed around by a jet coming out of it, by 'reaction,' they call it. Ever see one of those lawn sprinklers that is spun by the water that it sprinkles? Well, take a turbine that's run on that principle, the wheel has got to run as fast as the water to get the energy all out."

"How so?" I asked.

"Well, supposing we had a tank like this on a car, Fig. 3, and air pressure on the water so as to make it spout out with a certain velocity. Then in order that the water may come out of the nozzle and fall dead onto the ground the car must run as fast as the water does, so that it can just pay the jet of water out like a rope and let it lay dead between the tracks. If the car is carrying the nozzle ahead as fast as the water comes out of it then the forward motion of the water with the nozzle will just balance the backward velocity with which it squirts out of it and, so far as the ground is concerned, the water will have no motion whatever."

"And if you held the car still the jet

would push like blazes," I ventured, "and when it got up to the speed of the jet it wouldn't be pushing at all. In one case your power is all push and no speed, and in the other all speed and no push."

"What makes you think so?" Pegleg asked. "The tank don't know whether it's on a railroad car or in a brewery, or whether it's playing backward or forward or sidewise. A certain amount of pressure will make that stream come out of there with a certain velocity wherever the tank is and whatever it is doing, and a certain amount of water leaving with

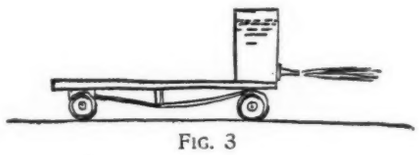


FIG. 3

a certain velocity will need a certain push to give it that velocity, and as action and reaction are equal and opposite it will react on the tank with the same force."

"And the energy that the car gets out of it is this force times the distance that it moves?" I argued.

"Sure thing!"

"Well, now, if you double up that velocity of the jet you put eight times the energy into it, don't you?"

"Yes."

"Well, how do you get eight times the energy out of the jet by running the car twice as fast; only twice as far in the same time?"

"Because, my boy, you had to have four times the pressure to get that doubled velocity and that makes four times the pressure or reaction on the car and four times the pressure times twice the distance makes eight times the energy."

I was ashamed of having been caught again on this pressure thing, for it was the same point upon which I had gone wrong regarding the pump and the hose.

"How can you tell how hard a jet will push; what the shove on the car would be, for instance?" I asked.

"Do you remember the weight I told you about sliding on the ice? A pound of force got up 32 feet of velocity per second in a pound of matter. Just divide the velocity by 32 (or g) and you will have the pounds of force necessary to get up the given velocity in *one* pound of matter in a second. Multiply that by the number of pounds put into motion in a second and you will have the force required to squirt the jet. The force pushes backward as hard as it does forward, action and reaction being equal and opposite, so the jet reacts with a force equal to

$$\text{Force} = \frac{\text{weight} \times \text{velocity}}{g}, \text{ or } F = \frac{wv}{g}$$

Take your weight in pounds and the velocity in feet and both per second, because g is in feet per second, if you call it 32 or thereabout."

"And the product of this force and the distance that the car moves is the energy taken up by the car?" I reasoned.

"Yes, if the velocity of the car is the same at the end as at the beginning."

"If the car moves with half the velocity of the jet, the space that it will go through in a second is the velocity divided by 2, isn't it?"

"Sure as preaching!" assented the old man.

"Then the energy taken up by the car per second, if it moved at one-half the velocity of the jet, would be

$$\text{Energy} = \text{force} \times \text{space}$$
$$E = \frac{wv}{g} \times \frac{v}{2} = \frac{wv^2}{2g}$$

I didn't go to do it but I had brought out the formula for the total energy of the jet which he had explained to me the day before.

"Why!" I exclaimed, "That's all there is in it."

"What's that? Let's see," said the old man, reaching for the pad.

I passed it to him, explaining that he had said that the car must run as fast as the jet came out so that it could pay it out like a rope, and let it fall dead on the ground in order to get out all the energy, but that here it figured out to have taken up all the energy that the jet had in it with the car going at only half the speed of the jet.

"There's something funny about that," said Uncle Pegleg, settling down further into his chair and screwing up his lips as he did when he was puzzled, and he was still screwing at it when I went to start her up.

Examination in Thermodynamics

The Polytechnic Institute of Brooklyn is a pioneer in evening-class work. It was among the first colleges of engineering to give evening courses which are equal in scope and quality to those offered at the day sessions. A man may secure the degree of Mechanical Engineer, Civil Engineer or Electrical Engineer by attending a sufficient number of evening courses to pass the required examinations and secure the necessary number of counts.

In the April 5 issue, we published a sample of the kind of work which Polytechnic is doing in the form of a set of examination questions in thermodynamics which was put to the junior class at the end of the first semester of the present year. Sufficient interest in these problems was evinced to warrant the publishing of the answers thereto.

Complete answers to the list of examination questions given to the junior class in Polytechnic Institute, Brooklyn. The questions were published in POWER *for April 5 on page 643.*

1. No engine can have an efficiency exceeding

$$\frac{T-t}{T}$$

in wihch T and t are the highest and lowest temperatures attained, expressed in absolute degrees. (To express temperatures in absolute degrees, add 460 to the Fahrenheit temperature). For the engine in question, the maximum possible efficiency is then

$$\frac{(300+460)-(212+460)}{(300+460)} = 0.1158$$

One horsepower-hour is equivalent to

$$\frac{33{,}000 \times 60}{778} = 2545 \text{ } B.t.u.$$

the figure 778 denoting the number of foot-pounds in one B.t.u. At 0.1158 efficiency, the engine must then receive, per horsepower-hour,

$$2545 \div 0.1158 = 22{,}000 \text{ } B.t.u.$$

and since each pound of steam "contains" 1100 B.t.u., the minimum possible steam consumption, corresponding to maximum possible efficiency, is

$$22{,}000 \div 1100 = 20 \text{ } \textit{pounds per horsepower-hour}$$

2. Air conforms closely to the law

$$PV = RT$$

in which,

P = Absolute pressure in pounds per square foot,

V = Volume of one pound in cubic feet,

R = 53.36, an experimentally determined coefficient,

T = Absolute temperature.

Then by substitution,

$$2000 \times 144 \times V = 53.36 \times (460+65)$$
$$V = 0.097 \text{ } \textit{cubic feet}$$

The volume of the tank is then,

$$10 \times 0.097 = 0.97 \text{ } \textit{cubic feet.}$$

3. Since $P_1 = P_2$, the path 1 — 2 is of constant pressure, $PV^0 = c$. Since $V_2 = V_3$ the path 2 — 3 is of constant volume, $PV^\infty = c$. A $P - V$ diagram of the cycle would then appear as in the illustra-

tion, the path 1 — 3 being a hyperbolic curve. The area of this cycle represents the work done and also the heat expended. Drawing the dotted lines, this work area is

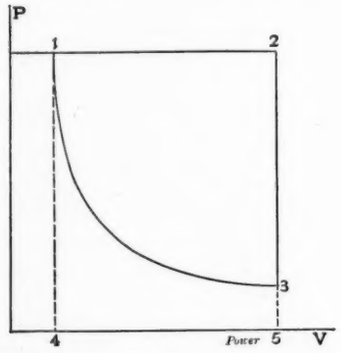
$$W = P_1 (V_2 - V_1) - P_1 V_1 \log_e \frac{V_3}{V_1}$$

the second term being the formula for the work area under a hyperbolic curve. To find V_1:

$$P_1 V_1 = R T_1$$

$$V_1 = \frac{R T_1}{P_1} =$$

$$\frac{53.36 \times (3000 + 460)}{100{,}000} = 1.85 \text{ cubic feet}$$



We then have,

$$W = 100{,}000\ (40 - 1.85) -$$

$$\left(100{,}000 \times 1.85 \times \log_e \frac{40}{1.85}\right) =$$

3,246,000 *foot-pounds*

and the amount of heat converted into work is

$$3{,}246{,}000 \div 778 = 4170 \text{ B.t.u.}$$

4. We first find $P b$:

$$P a V a^{1.7} = P b V b^{1.7}$$

$$P b = P a \left(\frac{V a}{V b}\right)^{1.7} =$$

$$1000\ (\tfrac{1}{2})^{1.7} = 307.7$$

The increase of internal energy is, the value of y for air being 1.402,

$$\frac{P b V b - P a V a}{y - 1} =$$

$$\frac{(307.7 \times 2) - (1000 \times 1)}{1.402 - 1.0} = -956$$

foot-pounds

the negative result denoting that the internal energy has *decreased* in passing from a to b. The formula for external work done along such a path as that given is, n being the exponent of the path,

$$\frac{P a V a - P b V b}{n - 1} =$$

$$\frac{(1000 \times 1) - (307.7 \times 2)}{1.7 - 1.0} = 549 \text{ foot-pounds}$$

The heat absorbed is the sum of the external work done and the internal energy inparted, or

$$549 - 956 = -407 \text{ foot-pounds} =$$

$$-\frac{407}{778} = -0.522 \text{ B.t.u.}$$

the negative result denoting that heat has been *emitted,* which might have been anticipated from the fact that the path slopes downward more rapidly than the adiabatic,

$$p v^y = c$$

Second Method—The specific heat along any polytropic path is given by the formula

$$s = l \frac{n - y}{n - 1}$$

in which l is the specific heat at constant volume, which for air equals 0.1689. This leads to

$$s = 0.1689 \frac{1.7 - 1.402}{1.7 - 1.0} = 0.0723$$

The temperatures at a and b are

$$T a = \frac{P a V a}{R} = \frac{1000 \times 1}{53.36} = 18.77$$

$$T b = \frac{P b V b}{R} = \frac{307.7 \times 2}{53.36} = 11.54$$

The heat absorbed is equal to the gain of temperature, multiplied by the specific heat, or to

$$s\ (T b - T a) = 0.0723\ (11.54 - 18.77)$$
$$= -0.522 \text{ B.t.u.,}$$

as before.

5. In the illustration, we have

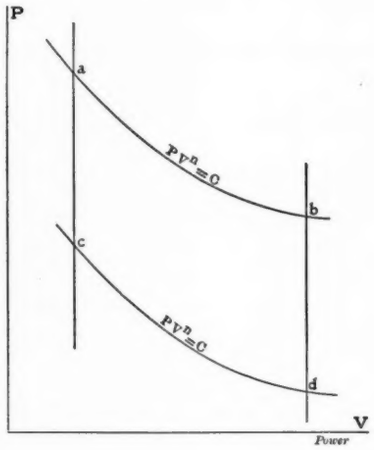
$$P a V a^n = P b V b^n \qquad P c V c^n = P d V d^n$$

and since generally $P V = R T$,

$$\frac{P a V a}{T a} = \frac{P b V b}{T b} = \frac{P c V c}{T c} = \frac{P d V d}{T d} = R$$

We may then write

$$\frac{P a V a^n}{\frac{P a V a}{T a}} = \frac{P b V b^n}{\frac{P b V b}{T b}} \text{ or } \left(\frac{V a}{V b}\right)^{n-1} = \frac{T b}{T a}$$



Similarly,

$$\left(\frac{V c}{V d}\right)^{n-1} = \frac{T d}{T c}$$

But,

$$V c = V a,\ V d = V b;$$

hence,

$$\left(\frac{V a}{V b}\right)^{n-1} = \left(\frac{V c}{V d}\right)^{n-1} \text{ and } \frac{T b}{T a} = \frac{T d}{T c}$$

or, by inversion,

$$\frac{T a}{T c} = \frac{T b}{T d}$$

which was to be proved.

6. The heat of the liquid of wet or dry steam at 327.8 degrees Fahrenheit is approximately

$$327.8 - 32 = 295.8 = h.$$

The latent heat of vaporization of the dry steam is

$$L = H - h = 1186.3 - 295.8 = 890.5.$$

The latent heat of vaporization for steam 0.95 dry is

$$0.95 \times 890.5 = 854 = L.$$

The total heat of the wet steam is

$$845 + 295.8 = 1140.8 = H.$$

The volume of the wet steam is

$$0.017 + 0.95\ (4.429 - 0.017) = 4.212,$$

the quantity 0.017 representing the specific volume of water. The entropy of the liquid, if the specific heat be taken as constant, is

$$\log \frac{T}{t} = \log_e \frac{327.8 + 460}{32 + 460} = 0.469$$

The entropy of vaporization is

$$\frac{L}{T} = \frac{845}{327.8 + 460} = 1.075$$

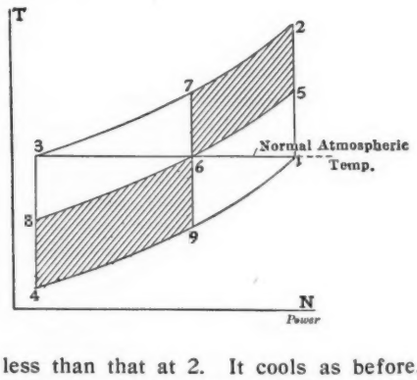
The total entropy of the wet steam is

$$0.469 + 1.075 = 1.544.$$

7. In the single-stage apparatus, we have adiabatic compression 12, cooling at constant pressure 23, to the initial temperature $T_1 = T_3$, expansion (adiabatic) 34, warming of the exhausted air from the engine at constant pressure along 41, so that it (or its equivalent) enters the compressor at normal atmospheric temperature T_1.

The inclosed area 1234 represents the net work expenditure, measured in heat units.

In two-stage compression, adiabatic compression ceases sooner, at 5, and the air is passed through an intercooler where its temperature is reduced to $T_6 = T_1$, at constant pressure along 56. It is then recompressed to the desired pressure along 67, the temperature at 7 being



less than that at 2. It cools as before, after compression, along 73, before reaching the engine at 3. The area 7256 represents a saving of work at the compressor. Expansion in the two-stage engine along 38 is similarly stopped early, and the air allowed to regain atmospheric temperature at constant pressure along 86. A second expansion 69 then follows. The pressures at 4 and 9 are equal, but the temperatures are different. So also at

the points 7 and 2. The saving of work in the engine is represented by the area 8694.

8. We have given,

$V_2 = 1$ $P_2 = P_1 = 14.7$ $P_3 = P_4 = 100.$

Then since,

$$P_3 V_3 = P_2 V_2$$

$$V_3 = \frac{P_2 V_2}{P_3} = \frac{14.7 \times 1}{100} = 0.147$$

The area 4321 is the work per cycle; it is

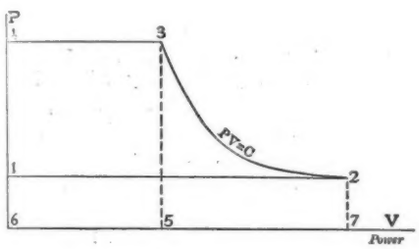
$$6435 + 5327 - 6127 = P_3 V_3 +$$

$$P_3 V_3 \log_e \frac{V_2}{V_3} - P_1 V_2 =$$

$$144[(100 \times 0.147) + \left(100 \times 0.147 \log_e \frac{1}{0.147}\right) -$$

$$(14.7 \times 1)] = 144\,[14.7 + 28.1 - 14.7] =$$

$$4050 \textit{ foot-pounds}$$



This work might be about 60 per cent. of that necessary per cubic foot of free air in an actual compressor. A 2000-foot compressor, for example, should indicate about

$$\frac{2000 \times 4050}{0.60 \times 33000} = 409 \textit{ horsepower}$$

9 (b). $PV^{\frac{17}{16}} = c$, Rankine's equation for relation between pressure and volume of dry steam;

$H = H_{212} + a\,(t - 212) - b\,(t - 212)^2$, Davis' equation for total heat in dry steam;

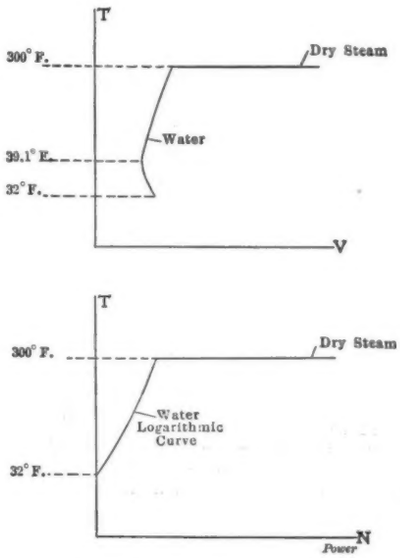
$e = \frac{P(W - V)}{778}$ external work of vaporization, in B.t.u., when

P = Pressure in pounds per square foot,

W = Volume of one pound of steam at pressure P,

V = Volume of one pound of water.

9 (a).



10. The factor of evaporation is the ratio of the member of B.t.u. imparted to the feed water in generating steam, to 970.4. From problem 6, the total heat of the wet steam, measured above 32 degrees, is 1140.8. Feed water at 212 degrees Fahrenheit already contains

$$212 - 32 = 180 \textit{ B.t.u.}$$

The amount of heat imparted to each pound of water is then

$$1140.8 - 180 = 960.8 \textit{ B.t.u.},$$

and the factor of evaporation is

$$\frac{960.8}{970.4} = 0.99$$

11. In the illustration, the expansion is from 1 to 2, and we have, from problem 6, entropy at

$$1 = 32 = 1.544.$$

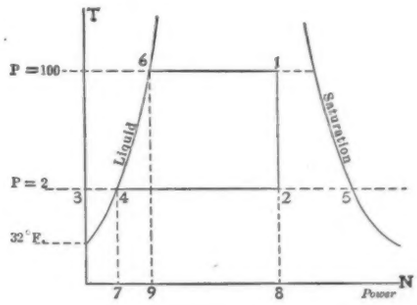
We have also given, entropy of liquid at

$$T_2 = 34 = 0.1749,$$

and entropy of vaporization at

$$T_2 = 45 = 1.7431.$$

The dryness at 2 is



$$\frac{42}{45} = \frac{32 - 34}{45} = \frac{1.544 - 0.1749}{1.7431} = 0.783$$

12. In the previous illustration, the cycle is 4612. The efficiency is

$$\frac{\textit{Heat converted into work}}{\textit{Gross heat absorbed}} =$$

$$\frac{4612}{74618} = \frac{7469 + 9618 - 4287}{7469 + 9618} =$$

$$\left(\begin{array}{c}(\textit{Heat of liquid at } T_6 - \textit{heat of liquid at } T_4) \\ + (\textit{heat of vaporization of the wet steam} - \\ \textit{heat of vaporization of the steam at the} \\ \textit{end of expansion}\end{array}\right)$$

$$\left(\begin{array}{c}(\textit{Heat of liquid at } T_6 - \textit{heat of liquid at } T_4) \\ + (\textit{heat of vaporization of the wet steam})\end{array}\right)$$

The heat of vaporization of the steam at the end of expansion is not given; but we may compute it as follows: The area

$$4287 = 42 \times 82 = (32 - 34) \times 82 =$$

$$(1.544 - 0.1749)\ (126 + 460) =$$

$$801 \textit{ B.t.u.}$$

The efficiency of the cycle is then, taking values from problem 6:

$$\frac{[295.8 - (126 - 32)] + 845 - 801}{295.8 - (126 - 32) + 845} =$$

$$\frac{201.8 + 845 - 801}{201.8 + 845} = \frac{245.8}{1046.8} = 0.235$$

Auxiliary Apparatus in Close Quarters

By using an engine of the Lentz type, which has a short base, and by employing a short-center rope drive, the Hammermill Paper Company was able to install auxiliary power equipment in very limited quarters.

Seldom is it possible to do as one would like in arrangement and equipment when alterations are necessary. Every man who tackles a job of planning for enlargement of productive capacity and its consequent demand for increase of power knows at the outset that the problem involves comparison of various plans and a discussion of relative costs and economies before a decision can be reached.

Sometimes things work out all right and sometimes a great deal of squirming is needed before all the conflicting conditions are satisfied or compromised.

Recent changes that became necessary at the Hammermill Paper Company's mills at Erie, Penn., were made very satisfactorily and economically, yet at the expense of importing an engine of a type not yet being built in this country. The fact that a special engine was needed so badly as to justify the payment of a high import duty for its admission to the country is an indication of the difficulty of the problem.

A large cross-compound Corliss engine was the sole source of power for all of the mills. Its broad wheel carried the ropes of two English or multiple-loop rope drives, about two-thirds of the rope leading forward to the main line shaft and the other third running backward between the engine cylinders to drive a secondary shaft.

As additional machinery was gradually installed in various parts of the mill, the engine became overloaded and relief was necessary. The natural thing to do was to relieve the engine of the load imposed by the secondary shaft and leave it only the main line shaft to drive. This de-

cision being made, the problem was to install within the available space and under existing conditions an engine and drive for the secondary line.

No prime mover of inferior economy would be acceptable, and within the space available no economical engine of standard American type could be installed. Being familiar, through its German connections, with the Lentz type of engine, the Hammermill company decided to purchase and import an engine of this type and to make the connection with the line shaft through a short-center rope drive of the Dodge American system.

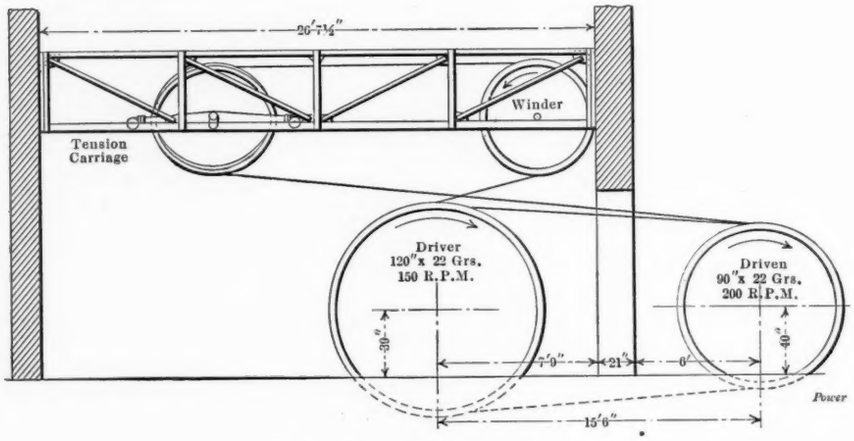


FIG. 1. ARRANGEMENT OF DRIVE

The facts of the case are summed up in the statement that under the conditions imposed, and to accomplish the results desired, the best and most economical solution of the problem was the combination of this extremely short type of engine and the Dodge rope drive, which operates with success on short centers. Fig. 1 is a diagrammatic section showing the arrangement of the rope-drive system, while Fig. 2 is a general view of the engine and the overhead tension carriage of the drive.

The distance on centers from the engine shaft to the line shaft is only 15 feet 6 inches, the sheave diameters, giving speed increase from 150 revolutions at the engine to 200 at the line shaft, are 120 and 90 inches respectively, leaving about 6½ feet of space in the clear between. The drive consists of 22 wraps of rope served by a tension carriage traveling on a horizontal track of steel construction.

The engine is a tandem compound with cylinder diameters, reducing metric measures to nearest inches, of 24 and 38 inches. The stroke is 28 inches. The steam pressure carried is 150 pounds; the steam is superheated 100 degrees. The engine runs condensing, and, although not operating under the most economical load, shows a steam consumption of only 11½ pounds per horsepower-hour.

The normal rating is 750 horsepower and the maximum 930 with ten atmospheres (147 pounds) initial cylinder pressure. The guaranteed economy is 13.34 pounds per horsepower-hour at ten atmospheres with dry and saturated steam or 11.68 pounds with steam superheated to 480 degrees Fahrenheit, or 116 degrees above saturation at ten atmospheres. The engine was imported complete with the exception of its flywheel, which was furnished by the Dodge Manufacturing Company. The wheel is of the plain balanced type cast in halves, joined by bolts at hub and rim, and by I keepers shrunk into the sides of the rim. The diameter is 12½ feet, the face width 12 inches and the weight 14 tons.

A continuous oiling system is installed for economical and automatic lubrication of the engine. Overhead in Fig. 2 may be seen a supply tank from which the oil feeds by gravity through suitable piping directly to the bearings.

Drippings drain to a filter in the basement, whence the purified oil is pumped to the overhead reservoir to be used again. The White Star continuous oiling system, which is used, effects a saving of from 50 to 80 per cent., as compared to ordinary hand oiling, while at the same time it improves the effectiveness of the lubrication.

The features of the engine are: extreme simplicity and compactness; greatly reduced number of parts in valves and valve gears; a very simple shaft-driven governor, which, if stopped for any reason, will shut the engine down instead of letting it run away; the possibility of running at a very high speed, up to 300 revolutions per minute or more without impairing the economy; and poppet valves which are seated quickly, yet without shock, and are particularly adapted to high pressures and high superheat, and which—most important of all—have no frictional surfaces, either sliding or rotary, and therefore need no lubrication and remain always tight. In Germany, a steam consumption of less than 10 pounds per horsepower is reported to have been attained with highly superheated steam.

The Lentz system has been adopted widely abroad and is used on locomotives and marine engines as well as in stationary practice. A large number of engine builders in Germany, Holland, Belgium, France, Italy and England are using the Lentz patents. The American rights have been acquired by the Erie City Iron Works, Erie, Penn.

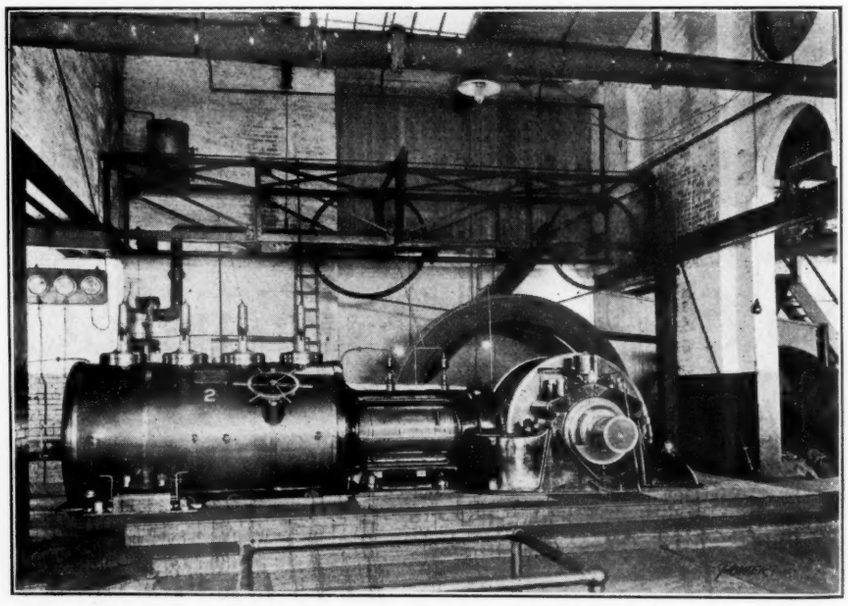


FIG. 2. THE LENTZ ENGINE AND DODGE ROPE DRIVE IN CLOSE QUARTERS

Expansion in Steam Pipes

By W. L. Durand

The power-plant engineer is frequently called upon to compute the expansion in steam-pipe lines. For convenience in such cases a set of curves has been drawn, showing the expansion for different lengths of cast-iron pipe at varying temperatures. By multiplying these values by certain coefficients, the expansion of brass and wrought-iron pipes can be found.

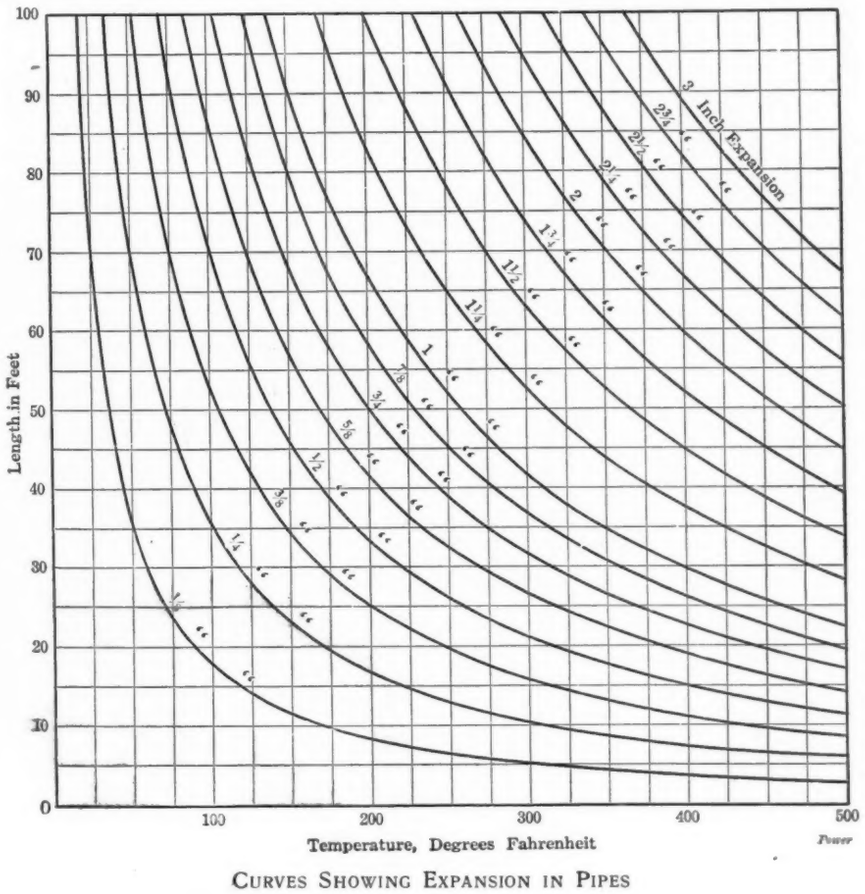
Among the many problems that confront the power-plant engineer is that of satisfactorily taking care of the expansion in steam pipes. In many of the newer plants using pressures of 175 pounds and 200 to 300 degrees superheat, this becomes a problem in itself.

From many experiments it has been found that wrought iron expands 0.0000066 per cent. for each degree Fahrenheit rise in temperature between 32 and 100 degrees and this amount increases until at 500 degrees it is 0.00000814 per cent. This increase in length is called the coefficient of expansion. The rule for finding the lineal expansion of any metal is as follows:

Expansion = length × increase in temperature × coefficient of expansion.

While this formula is very easy and simple to use, still one may not have at hand the various coefficients of expansion for varying temperatures, and if many problems are to be solved much time will be saved by the use of a set of curves similar to the accompanying chart. This is plotted for cast iron and the expansion to 500 degrees Fahrenheit, for every ⅛-inch expansion up to 1 inch, and for every ¼ inch up to 3 inches. The following coefficients for the different temperatures were used in laying out the chart:

100 degrees	0.00000600
150 degrees	0.00000612
200 degrees	0.00000626
250 degrees	0.00000642
300 degrees	0.00000660
400 degrees	0.00000700
500 degrees	0.00000740



CURVES SHOWING EXPANSION IN PIPES

for other metals may be found by multiplying the result taken from the chart by the ratio of their coefficients of expansion to that of cast iron. For wrought iron this is 1.1 and for brass 1.6. The curves are plotted from 0 to 100 feet and from 0

Suppose it is desired to find the expansion of a wrought-iron steam pipe 55 feet long when carrying steam at a pressure of 150 pounds gage, with the surrounding air at 70 degrees Fahrenheit. The temperature corresponding to 150 pounds is 366 degrees so that the rise in temperature will be 296 degrees. Referring to the chart we find that the expansion corresponding to 296 degrees and 55 feet is 1¼ inches. Multiplying this by 1.1 for wrought iron we find the expansion of the steam pipe to be 1⅜ inches.

The use of the chart may be greatly extended by finding the expansion for such part as will come within its limit and then multiplying this expansion by the ratio of that part to the whole. For example, if we want to find the expansion of a cast-iron pipe 800 feet long with a rise of 200 degrees in temperature, we find the expansion for 100 feet with a rise of 200 degrees to be 1½ inches, so that for 800 feet the expansion will be eight times as much or 12 inches.

Alaska Has Vast Deposits of Coal

According to Richard Hamilton Byrd, in the *World To-day*, the geological work of the Government in Alaska shows an aggregate of 8,106,880 acres of coalfields, and of these 769,280 acres have been surveyed in such detail as to warrant the statement of the Geological Survey, always highly conservative, that in these areas there is a reasonable degree of certainty that commercial coal beds can be opened up. In considering the coal underlying these 769,000 acres, the Survey, in a report to the National Conservation Commission, estimated a tonnage of 15,104,500,000 tons of minable coal.

"In view of the conditions," the statement concludes, "it is perhaps conservative to multiply the figures of 15,104,500,000 tons by ten or even one hundred to arrive at an approximation of the fuel resources of this vast, little explored region." And this does not take into consideration, apparently, the ninety million acres of totally unexplored territory, geologically, but in which coal is known to exist, and which, it is fair to assume, contains its share.

Great as is Alaskan gold reserve—the small Seward peninsula alone producing annually, and promising for many years to come, a sum equal to the purchase price of Alaska—the Territory's coal resource is of far greater value, albeit the latter will contribute immensely to the production of the former.

Furthermore, Alaska's stores of high-grade fuel cannot be equaled in quality west of the Rockies.

Electrical Department

Especially conducted to be of interest and service to the men in charge of the electrical equipment.

The Electric Elevator

By William Baxter, Jr.

The Elektron System

(Continued)

The starting switch of the Elektron controller, partly described last week, is located within the controller box. It surrounds the operating shaft *S*, and consists of a number of copper disks mounted upon the shaft, but insulated from it and also from each other, and corresponding stationary contacts with which the disks come into contact whenever the shaft is turned to start the elevator. The construction of these disks and stationary contacts, and their location, can be understood from the drawings, Figs. 118 and 119. The first drawing is a view endwise of the shaft, and shows the outline of a disk with about one-quarter of it cut away, and also a shorter segment. An edge view of these is given in Fig. 119, which is an elevation of the upper part of the controller box, taken parallel with the shaft *S*. Two of these disks slide into stationary contact jaws that are connected to the main line, and are marked "Line disks" in Fig. 119; the central disk slides at the same time into the contact jaws marked *J J'* and thereby closes the circuit of the brake magnet.

When the shaft is rotated in either direction, the first movement causes the three disks to slide into their respective jaws, thereby connecting the motor to the line and at the same time energizing the brake magnet. To close the line connections, however, it is necessary for the disks to rotate far enough to slide through the two sets of contact jaws marked *H, K* and *H' K'*, in Fig. 118, and this movement is more than is necessary to enable one or the other of the cams *D, D'*, Fig. 117, to throw the reversing-switch blades to the running position. Therefore the reversing-switch contacts are closed before the line switches are closed. The contacts *H* and *K* are arranged to swing around the spindles *L* upon which they are mounted, so as to compress a spring *M*; the result is that when the switch is opened, as the disks pull out of the jaws the latter are jerked away quickly, to break the flash abruptly.

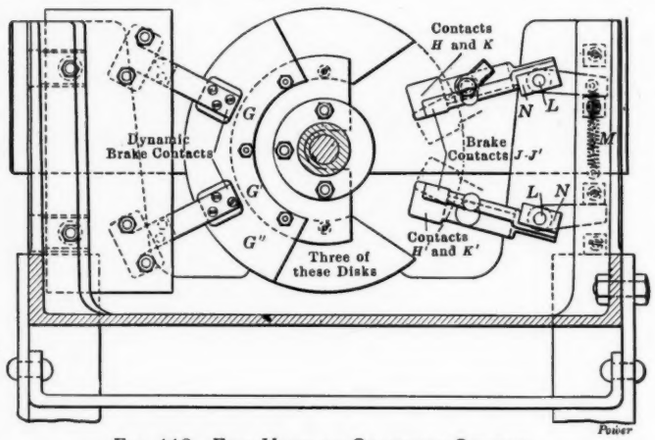


Fig. 118. End View of Starting Switch

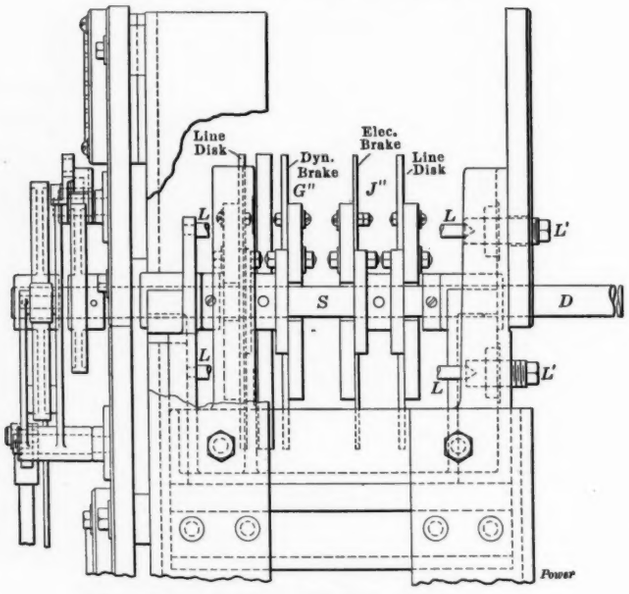


Fig. 119. Side View of Starting Switch

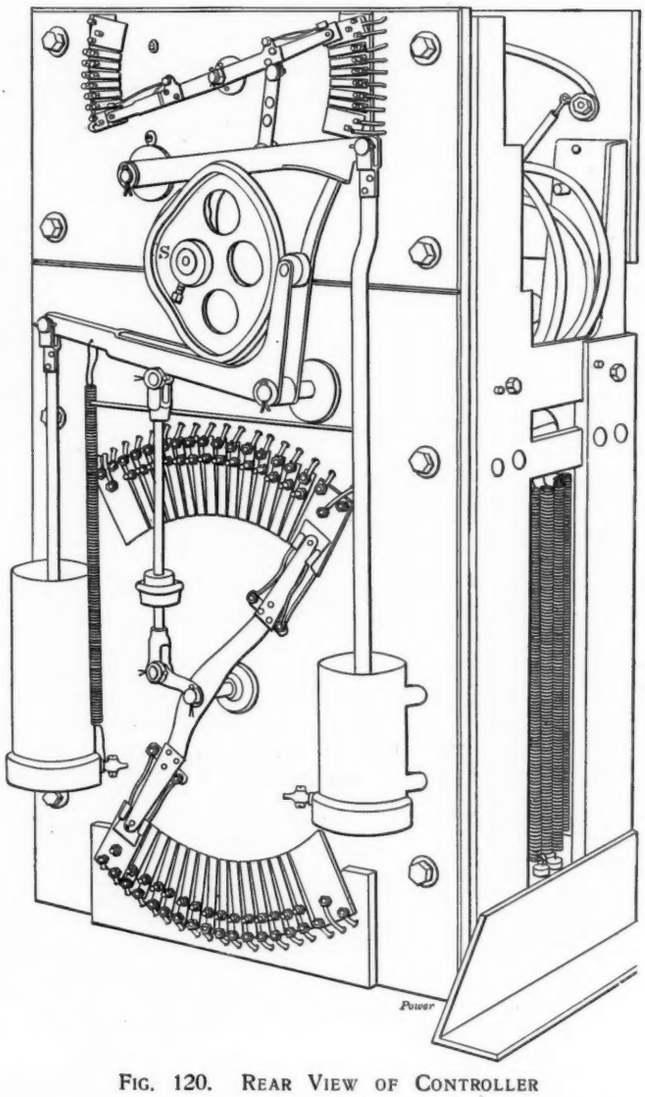


Fig. 120. Rear View of Controller

The segment G'' in Fig. 118, upon which the contacts G and G' rest, closes a dynamic braking circuit around the motor armature when the motor current is cut off. The construction of the jaws H, K and J is shown in Fig. 120, and also the spindle L upon which they are mounted. The jaws are insulated from each other, the blocks N being made of insulating material.

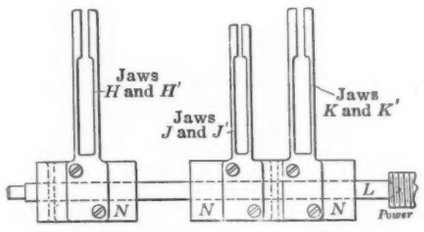


FIG. 121. CONTACT JAWS

The back of the controller illustrated in Fig. 114 is shown in Fig. 121. The parts at the bottom of the panel act to cut out the starting resistor, and those at the top act similarly to cut resistors into and out of the shunt field circuit to increase and decrease the speed of the motor. The operating shaft S, which runs through to the back of the controller box, carries on its end two cams, one of which actuates the lower switch lever, that cuts out the starting resistor, and the other the upper lever, that controls in the field resistor. These cams are so set that all of the starting resistor is cut out before any of the field resistor is cut in, and means are provided to prevent the apparatus from acting in any other way. When the operating shaft S is rotated to the stop position, the cam is in such a position that it holds the switch levers in the stop position; that is, the lower switch lever is rotated clockwise as far as it will move, cutting into the armature circuit all of the starting resistor coils, and the upper lever is moved counter-clockwise as far as it will go, in which position it cuts out all the resistor in the field circuit. The two levers are shown in the stop position. When the operating shaft is rotated in either direction, the cams act first to release the lower switch lever, and shortly thereafter to release the upper lever. When released by the cams the levers are drawn over their switch contacts by the weight of cam levers and their parts, and two dashpots are provided to regulate the rapidity with which the levers move. The action of these switches may be more clearly understood by reference to Fig. 122, which is a face view of the mechanism. It will be noticed that cam A can rotate through a considerable angle; that is, until its center line reaches the position F or F', before the roller A' can move, because this part of the cam is a circular curve concentric with the shaft. The cam is made this shape so that the starting and reversing switches may be closed before A' moves. When the cam moves through the angle from F' to G, the roller A' can move to the left far enough to permit the lever B to drop and carry the switch lever L over to the extreme left position.

The lever C carries a roller D'' that rides on the cam E, and the circular part of this cam covers such an angle that when the roller A' reaches the point G on the cam A, the roller D'' reaches the point J of the cam E; consequently, when the cam A has rotated far enough to permit the lever B to swing L around to its extreme position, the cam E will be far enough around to permit the roller D'' to run down the incline from J to G', and permit the switch lever D' to drop in the direction of arrow b to the lowest position. The lever C, however, cannot drop when the cam E rotates far enough for the roller D'' to run down the incline from J to G, unless the upper end A'' of the lever B has moved far enough to the left to carry it beyond the curved surface C' on the end of the lever C. From this it will be seen that the extension A'', in connection with the curved plate C' on the lever C, constitutes a locking device to prevent the field resistor from being cut into the circuit until after all the starting resistor has been cut out of the armature circuit. This provision is

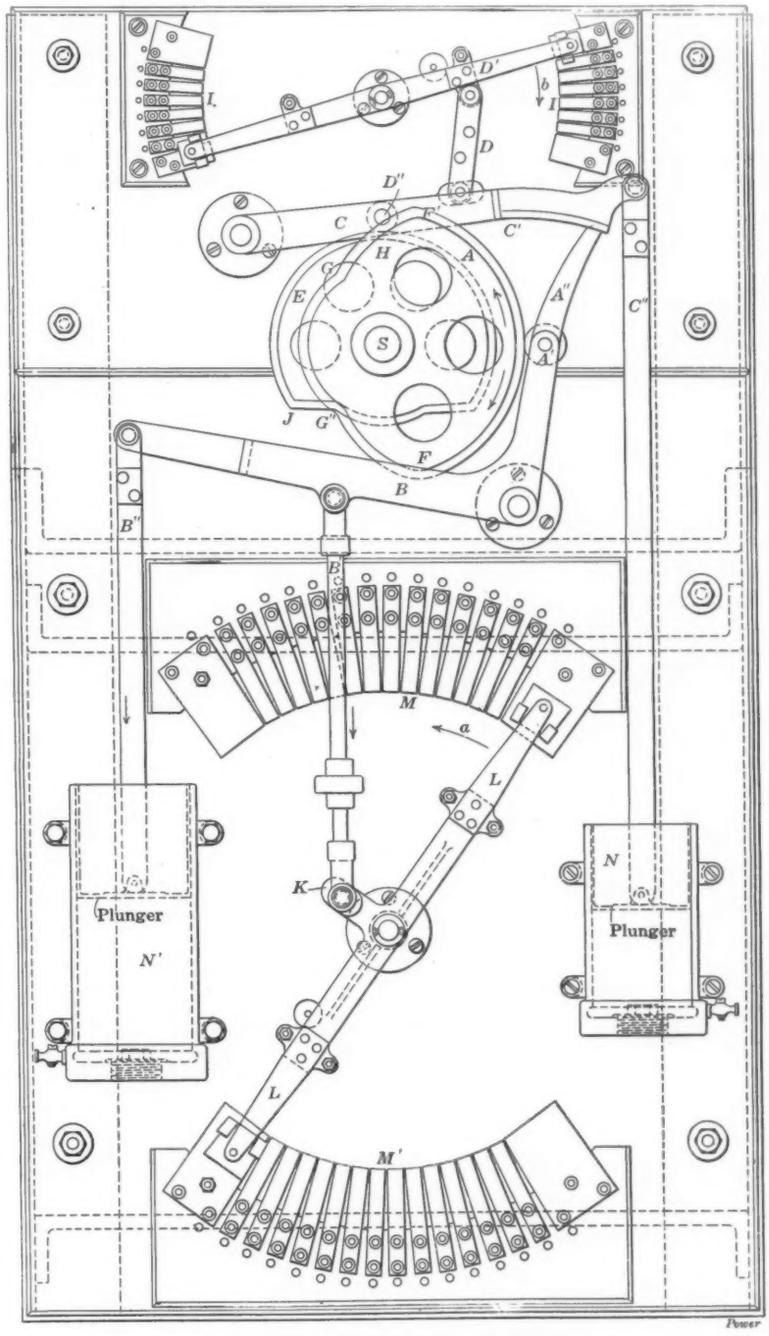


FIG. 122. ACCELERATING SWITCHES

necessary because the velocity with which the lever *B* descends and moves the lever *L* over the switch contacts is controlled by the dashpot *N'*, and it is possible for the operator to rotate the operating shaft *S* so rapidly that the cam *E* will free the lever *C* before the lever *L* has moved around to the extreme left-hand position. The curved plate *C'* on the end of the lever *C* is not directly under the lever but on one side, so that when the arm *A"* passes to the left of the face *C'* the lever is free to drop as fast as the dashpot *N* will permit it.

In starting the elevator, if the operator desires to get the car under full headway as rapidly as possible, he rotates the operating shaft *S* to the full running position at once; the starting resistor is then cut out of the armature circuit as rapidly as the dashpot *N'* will permit the switch lever *L* to swing around to the left, but during this time the switch lever *D'* is held stationary because the end of the arm *A"* is under the curved plate *C'* on the lever *C*. As soon, however, as *A"* passes to the left of *C'*, the switch lever *D'* begins to descend and cuts in the field resistor as fast as the dashpot *N* will permit. When the lever *L* first reaches its extreme position, the motor runs at its slowest speed, but immediately thereafter the speed begins to increase because the lever *D'* descends and the switch gradually cuts the resistor coils into the circuit of the shunt field winding. If the controller were moved only far enough to rotate the cams *A* and *E* far enough to carry the lever *L* over to the extreme left position, but not far enough to allow *A"* to free the lever *C*, then, with the parts held in this position, the elevator would speed up to its slowest velocity only; upon moving the controller shaft *S* the balance of the distance, the lever *C* would be released and the switch lever *D'* would cut the field resistor into the circuit, increasing the motor speed to its maximum. By operating the controller as described, the motor would operate as a two-speed machine.

With this controller also the operator can start up with different rates of acceleration, within reasonable limits. If he moves the operating wheel or lever in the car more slowly than the dashpot *N'* will permit the lever *L* to move, he will start the car more slowly than if he moves the wheel around to the running position in one rapid sweep. Another advantage is that in stopping, the speed of the motor is first reduced by the cutting out of the field resistor by the upward movement of the lever *D'*, the starting resistor being cut in after the speed has been reduced; then the motor is stopped by opening the main line and applying the brake. The advantage of reducing the speed before stopping is that more accurate stops can be made automatically at the top and bottom landings.

Electrical Equipment of Rail Roads*

By George Westinghouse

It is my intention in this paper to direct attention to the necessity for the very early selection of a comprehensive electrical system embracing fundamental standards of construction which must be accepted by all railway companies in order to insure a continuance of that interchange of traffic which, through force of circumstances, has become practically universal, to the great advantage of transportation companies and of the public. I feel that the time is ripe for such a selection unless we are willing to regard with complacency the extension of the existing diversified systems and the creation of conditions which will prevent the general use of the most practical methods of operation.

Indeed, the tendency seems to be toward diversity rather than unity, since different types of third-rail construction have been adopted, even for the several direct-current systems in and about New York City, which renders interchange of cars or locomotives difficult or impossible.

In the first days of railway operation, there was probably no idea of an interchange of traffic involving the use of the engines and cars of one railway upon the lines of another railway. It then made no difference whether the gage of track was 4 feet 8½ inches, the one ultimately selected, or one of a greater or lesser width by a few inches. However, the absolute necessity for uniformity of gage of tracks, both in the United States and Canada, became so apparent that in due course all of the roads which had gages wider than 4 feet 8½ inches changed to that standard. Among the remarkable achievements of engineering was the change of the tracks of an entire system of railway of some hundreds of miles within twenty-four hours, this change having, however, required months of preparation. The losses entailed in the change of gage and of equipment have ever since been serious burdens to most of those railways, in that the costs were in most cases covered by capital charges.

So far as steam railroads are concerned, there are now no obstacles to the interchange of traffic in the broadest sense, except in the size of vehicles in certain countries where the cost of changing tunnels and bridges would be prohibitive.

Requirements for Interchange of Traffic

To insure interchange of traffic, the fundamental requirements, so far as operation by steam is concerned, with full regard for safety, speed and comfort, are the following: A standard gage of track; a standard or interchangeable type of coupling for vehicles; a uniform interchangeable type of brake apparatus; interchangeable heating apparatus, and a uniform system of train signals.

The additional fundamental requirements for electrically operated railways are a supply of electricity of uniform quality as to voltage and periodicity; conductors to convey this electricity so uniformly located with reference to the rails that, without change of any kind, an electrically fitted locomotive or car of any company can collect its supply of current when upon the line of any other company; uniform apparatus for control of electric supply whereby two or more electrically fitted locomotives or cars from different lines can be operated together from one locomotive or car.

Electrical Systems for Railways

In the past twenty years three important electrical systems for the operation of railways have been put into practical operation, all using alternating current in whole or in part. These systems are the direct-current system, usually employing the "third-rail" conductor and alternating current for transmitting power when the distance is considerable; the three-phase alternating-current system with two overhead trolley wires, and the single-phase alternating-current, high-tension system with a single overhead trolley wire.

The Motors

In a notable case of the latter system, namely, that of the New York, New Haven & Hartford Railroad, the motors and controlling apparatus are arranged to utilize single-phase current from an overhead trolley wire at 11,000 volts, and also to be operated by current from the 650-volt third-rail system of the New York Central & Hudson River Railroad.

The equipment of the power houses which generate the current is essentially similar in the three systems which I have enumerated; but the systems differ in the kind of motors and the auxiliary apparatus for controlling them, and in the methods and apparatus for transmitting the current from the power house to the locomotive or car.

The three types of electric motors have certain fundamental differences in speed performance which are important factors in determining the advantages, disadvantages and limitations of the several systems.

The direct-current series railway motor automatically adjusts its speed in accordance with the load, running more slowly if the weight of the train be greater, or the grade steeper. The speed with a given load, however, is definite; it is dependent upon the voltage applied to the motor and cannot readily be varied. It is true that the speed can be decreased

*Abstract of a paper presented before the American Society of Mechanical Engineers.

by inserting a resistance in the motor circuit, but this is wasteful and is inadmissible except as a temporary expedient. It is true also that the motors may be connected in series, thereby dividing the pressure between two motors and reducing the speed one-half; or, if four motors, to one-quarter speed. As the system of current supply involves a fixed voltage, it is obvious that for emergencies no speeds much above the maximum speed determined in the construction of the motor can be obtained. Furthermore, on account of the high cost involved in maintaining a practically constant voltage throughout the system, the voltage supplied to the motors often decreases considerably at the end of long lines, at the time of heavy load, thereby further reducing the speed attainable. It often happens in railway service that a locomotive should be operated somewhat above the normal speed, and sometimes a locomotive designed for freight service has to be pressed into passenger service. In such cases the speed with the direct-current locomotive would be considerably less than that necessary to maintain the schedule speed. A special form of field control can be used, in certain cases, for varying the speed, but this has not been utilized very much.

The three-phase motor is inherently a constant-speed machine; it runs at approximately the same speed at light load and at full load; it runs at nearly the same speed up a grade as on level track, although the horsepower required on the grade may be several times that on the level. Conversely, it can run no faster on a level than it can climb a grade. In order to give a lower speed, however, the motors may be arranged upon the locomotive in pairs in a manner equivalent to the arrangement of two direct-current motors in series, just described. Motors may also be built for two or more speeds, but this involves some complication in windings and connections. In all cases lower speeds can be secured by the introduction of resistances which increase the losses and lower the efficiency. In no case can the speed in any of the arrangements of motors be appreciably higher at light load than at full load.

The motors are of the induction type without commutators and their inherent limitations, and are of relatively simple construction. The current is usually supplied at 3000 volts from two overhead lines through two sets of "trolleys." With three-phase motors as now constructed and arranged upon locomotives, it is possible with no additional complication so to utilize the motors when running down grade that they become generators and return power to the line, a feature of value in certain mountainous districts but not of controlling importance in the selection of a universal system.

The single-phase railway motor is a series-wound machine with speed characteristics very similar to those of the direct-current motor, as the speed at a given voltage is greater or less, depending upon the load. The speed with a given load is also greater or less, depending upon the pressure applied to the motor; and this is not limited, as with direct-current motors, to that supplied by the circuit, and to one-half and one-fourth of that pressure, but is capable of adjustment to any desired degree of refinement by means of auxiliary connections from the secondary winding of the transformer (on the locomotive) which is necessary for reducing the line voltage to the lower voltage required by the motors. Not only may numerous voltages less than the normal be obtained for lower speeds, but higher voltages can be provided to give speeds considerably above the normal. In this manner a wide range of efficient speed adjustment is secured which is impossible with other systems.

Like the throttle lever of the steam locomotive, the control lever of the single-phase locomotive may be placed in any one of its numerous notches to maintain the required speed. This facility of efficient operation over a wide range of speed and power requirements is one of the especially valuable features of the single-phase system.

The question of determination of the frequency for use on single-phase railways is one of very great importance. Twenty-five cycles are in general use for power-transmission purposes and have been adopted by nearly all the single-phase railroads now operating. The Midi Railway of France has adopted 15 cycles. The lower frequency permits of a marked reduction in the size of a motor for a given output, or conversely of a considerable increase in output from a motor of given dimensions and weight. Three-phase installations in nearly all cases employ approximately 15 cycles.

Locomotives equipped with each of the three types of motors mentioned are in successful operation and have demonstrated their usefulness and reliability in practical railway service. The three-phase motor, having a definite constant-speed characteristic, is particularly adapted to certain conditions; but on the other hand, it has a less general adaptability to the ordinary varying conditions of railway operation. The single-phase motor has a facility of voltage control which gives an efficient means of speed adjustment, and is in this particular superior to other systems. The relative weights and costs of the several types of motors, and of the locomotives designed to accommodate them, depend upon so many conditions that comparisons must necessarily be general. It will be found, however, that these differences in locomotive cost are in many cases more than offset by the cost of the other elements in the electrical system.

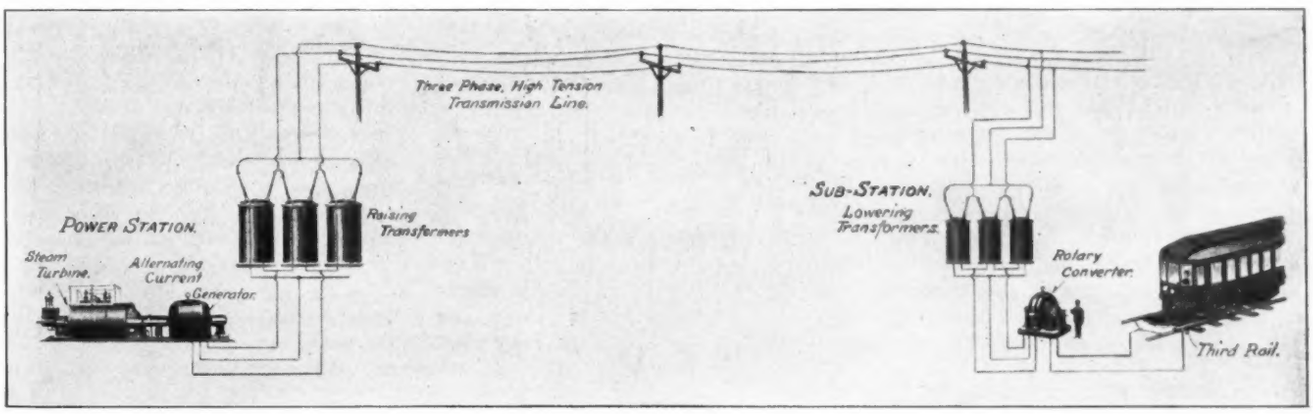


FIG. 1. DIRECT-CURRENT RAILWAY SYSTEM

TRANSMISSION OF POWER FROM POWER HOUSE TO LOCOMOTIVE

The controlling factor in the cost of electrification in nearly all cases is the system for transmitting power from the power house to the locomotive, and not the locomotive itself. The choice between the several systems must, therefore, be based upon a comparison of the complete systems. The differences between the methods of transmitting power are of far greater importance than the differences between power houses or between locomotives. The current for all systems is generated in usual practice as high-ten-

sion alternating current, for the reason that electric energy can be most economically transmitted by high-tension alternating current.

The transmission systems for the three types of locomotives are illustrated in Figs. 1, 2 and 3. Even a superficial glance at these diagrams gives the following comparison:

In the direct-current system the apparatus which intervenes between the alternating-current generator and the locomotive consists of step-up transformers in groups of three; a transmission line of three wires; transformers in groups of three, and rotary converters for changing the alternating current to direct current; a third-rail contact conductor, which for heavy work must often be supplemented by copper feeders; the track-return circuit, which must be provided with heavy bonds, and in certain cases supplemented by feeders and so called negative boosters.

For the three-phase system the links between the generator and the locomotives are step-up transformers in groups of three; a transmission line of three wires; substation transformers in groups of three; two overhead wires as the contact system; a track return which usually requires only inexpensive bonding.

For the single-phase system there are required a raising transformer; a transmission line of two wires; a lowering transformer in each substation; a single trolley wire; a track return, usually requiring only inexpensive bonding.

In certain cases where the distance from the power station is not more than 15 or 20 miles, the single-phase trolley wire can be supplied directly from the power house, with no transformers between the generators and the locomotives.

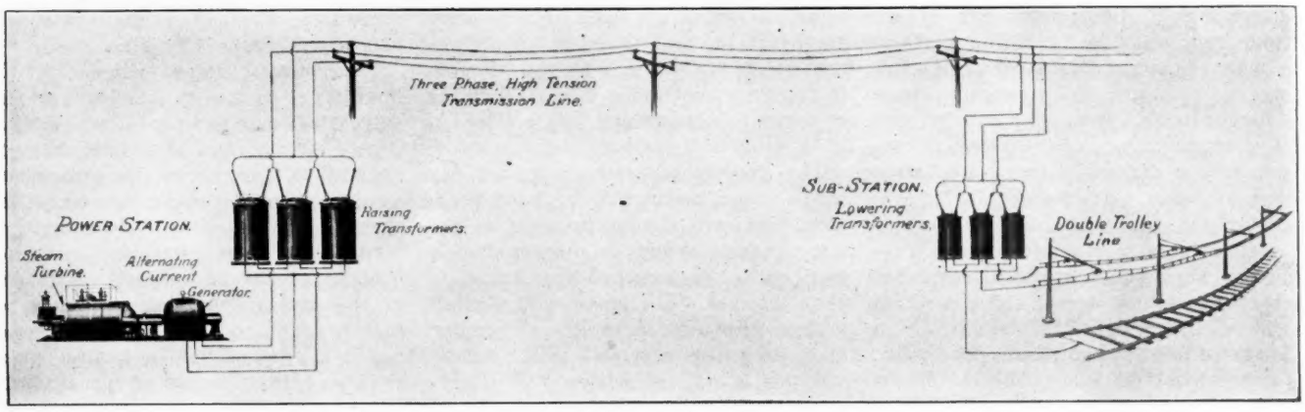


FIG. 2. THREE-PHASE RAILWAY SYSTEM

REQUISITES FOR A UNIVERSAL ELECTRIC SYSTEM

In selecting a proper electrical system for railway operation, it will probably be generally conceded that the following elements are of prime importance:

The electric locomotive should be capable of performing the same kinds of service which the steam locomotive now performs. This will be most readily secured by electric locomotives which can practically duplicate the steam locomotives in speed and power characteristics. This naturally calls for wide variation in tractive effort and in speed, both for the operation of different kinds of trains, and also for the operation of the same train under the varying conditions usually incident to railway service.

The electric locomotive should be able to handle heavier trains and loads, to operate at higher speeds, and in general to exceed the ordinary limits of the steam locomotive in these regards. The readiness with which several electric locomotives can be operated as a single unit enables any amount of power to be applied to a train.

The electric system should adapt itself to requirements beyond the ordinary limitations of the steam locomotive in small as well as large things. It should be adapted for use on branch lines, and for light passenger and freight service similar to that so profitably conducted by interurban electric roads, which in many cases run parallel to steam roads, not only taking away the traffic of the steam roads, but building up a new and highly profitable traffic, both in passenger and in express service.

A universal electrical system requires that power should be transmitted economically over long distances, and that the contact conductor should be economical to construct, both for the heaviest locomotives where the traffic is dense and for light service on branch lines. It should impose minimum inconvenience to track maintenance; should give minimum probability of disarrangement in case of derailment, or in case of snow and sleet, and should in general be so placed and constructed as to give a maximum assurance of continuity of service.

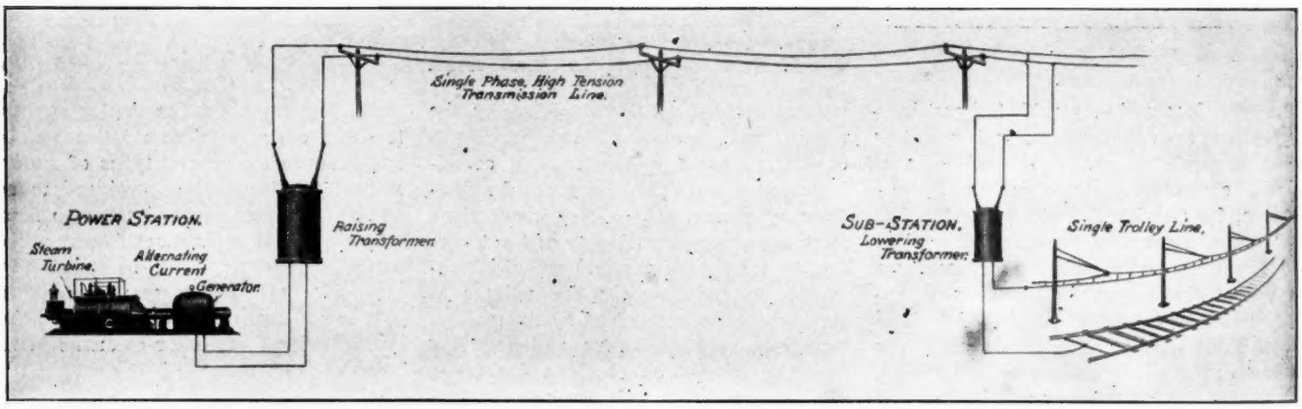


FIG. 3. SINGLE-PHASE RAILWAY SYSTEM

Gas Power Department

Elementary Lectures on the Gas Producer*

By Cecil P. Poole

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men.

The Wet Scrubber

After passing through the economizer, or upon leaving the generator, if the economizer and vaporizer are of the

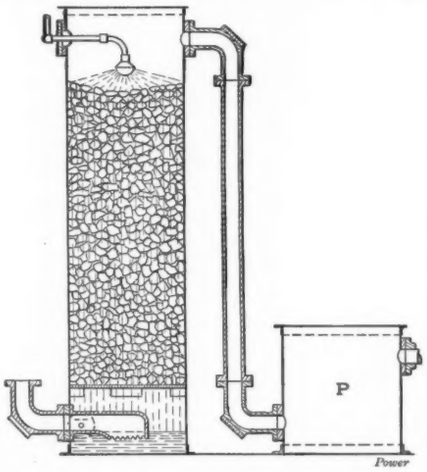


Fig. 5. Coke-filled Wet Scrubber

"built-in" sort represented in Fig. 3, the gases are carried through an apparatus known as the "wet scrubber," in order

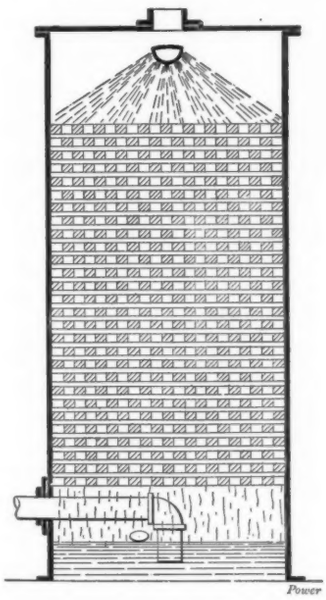


Fig. 6. Lattice-filled Wet Scrubber

to cool them further and also to cleanse them of minute particles of dust, ash, grit, etc., that they have picked up in the fuel bed of the generator. The wet scrubber is a tower-like structure almost completely filled with either crushed coke or wooden grids and containing a water spray at the top which keeps the coke or the grids covered with a film of cool water. The gases in passing through the small spaces between the lumps of coke, or the openings in the wooden grids, are broken up and forced to come into contact with the water-covered surfaces. When they have passed through the "filling" of the scrubber they pass finally through the water spray, which tends to

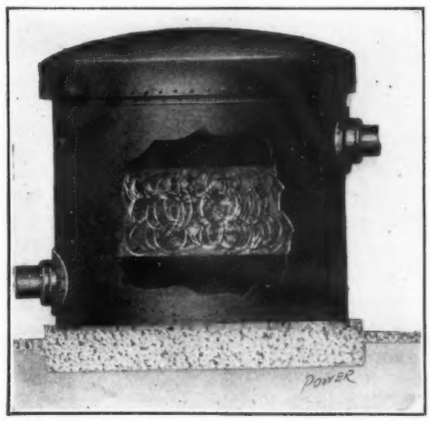


Fig. 7. Dry Purifier

wash out the particles of objectionable material. Fig. 5 shows a vertical section of a coke-filled scrubber and Fig. 6 is a corresponding section of a lattice-work scrubber. The gases from the economizer enter the bottom of the scrubber, where a pool of water is maintained by the descent of the water from the spray at the top. The mouth of the gas pipe is submerged in the water, so that the gases must pass through the water before ascending to the coke or grids; this removes the larger particles carried over by the gases and reduces the tendency to clog up the "filling" with accumulations of these larger particles. The gases then pass up through the filling and the spray, as just explained, and go to what is known as the "dry purifier," indicated at *P*, Fig. 5.

The Dry Purifier

The dry purifier is merely a mechanical filter consisting of a box or tank filled with excelsior, sawdust or some similar material which removes the moisture that the gas has picked up in the scrubber and also tends to take out any solid particles of matter that have escaped the filtering material and water in the scrubber. Fig. 7 illustrates the usual construction of the dry purifier. The shell is provided with a sort of grating or perforated shelf near the bottom, which supports the excelsior, and the gases are admitted to the compartment beneath this; they are compelled to pass through the

Fig. 8. Combined Wet Scrubber and Dry Purifier

mass of excelsior to reach the outlet pipe, which is located above the excelsior.

Combination Cleaners

In some cases the wet scrubber and dry purifier are combined in one struc-

*This is the second lecture of the series. The next lecture will deal with the principles of gasifying solid fuels.

ture, as represented in Fig. 8, where the dry filling is supported on a grid above the water spray in the top of the wet scrubber. This has the advantage of economy in floor space and the disadvantage of making the dry purifier more difficult to get at for cleansing the filling.

In other cases the scrubber structure contains three different grades of cleansing material or fillings, a coarse filling near the bottom, a finer filling in the central part and the usual dry-purifier filling at the top. Fig. 9 illustrates this construction. The bottom filling is a wooden lattice work, the central filling is of crushed coke, divided into two sections, each having its own water spray, and the top filling is that of the ordinary dry purifier.

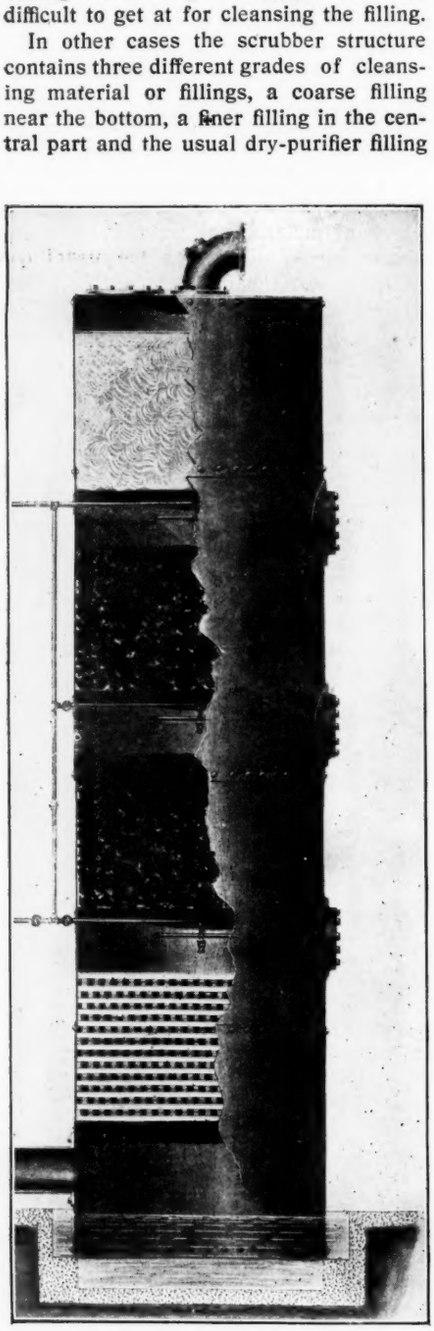


FIG. 9. COMPOSITE WET SCRUBBER, COMBINED WITH DRY PURIFIER

THE COMPLETE PRODUCER PLANT

In order to give the student a better grasp of the relations between the various members of the producer equipment, a complete plant is illustrated in Fig. 10, where the generator is indicated by the letter *G*, the scrubber by *S* and the dry purifier by *P*. The air intake is at *A*, the transfer pipe from the vaporizer to the ashpit, at *B*, and the air preheater or economizer at *E*. The hand blower *J* is for the purpose of supplying air to the fire in the generator at starting, when there is no other means of producing a draft, and the pipe *K* serves as a temporary chimney through which the gases formed by burning the coal escape to the atmosphere while the fire is being worked up. This pipe is commonly called the "purge" pipe, because it purges the producer of the gases made while the generator is being brought up to the regular working condition; these gases are not fit for use in an engine. A valve in the pipe is closed, shutting off the exit of the gases, when the generator has reached the proper condition for supplying gas to the engine. The generator shown here is equipped with a built-in vaporizer and an external economizer somewhat on the order of the one illustrated in Fig. 4.

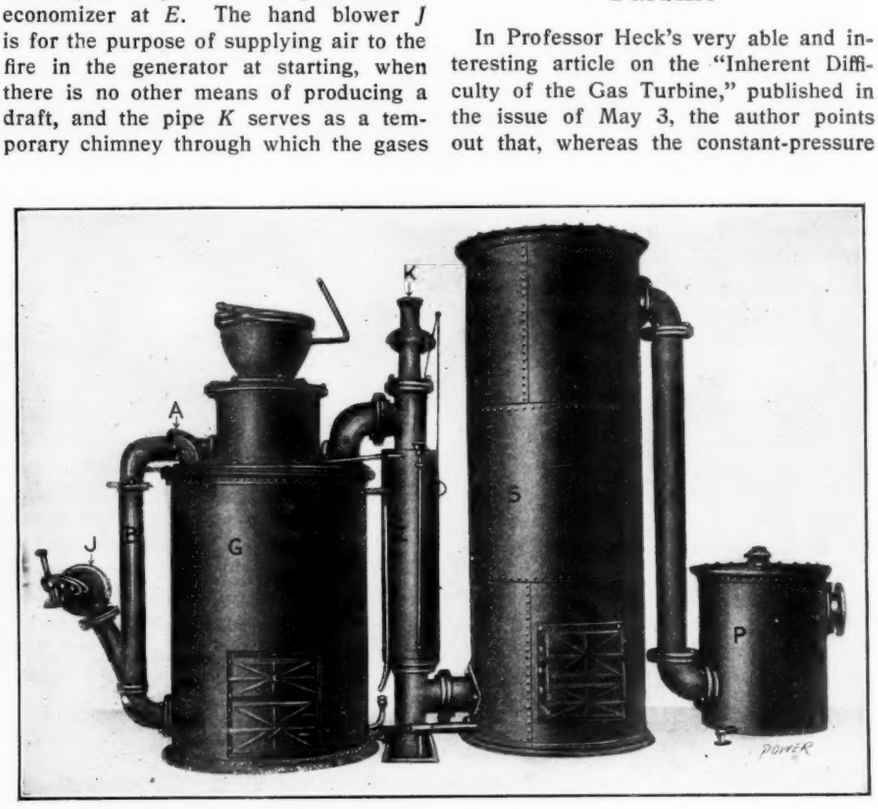


FIG. 10. A COMPLETE SUCTION PRODUCER PLANT

All of the apparatus thus far illustrated and explained belongs in the class of straight suction producers, in which the draft through the system is supplied by the suction of the engine piston during the intake strokes. The induced-draft or exhauster type of producer does not differ in any important detail from the general forms of construction here shown, but it has, in addition, a power-driven exhaust fan coupled to the outlet of the dry purifier to draw the air and steam into the generator and the gases out of it, thus relieving the engine of that work and keeping the gas under a slight pressure at the engine intake.

CORRESPONDENCE

Some Probabilities of the Gas Turbine

In Professor Heck's very able and interesting article on the "Inherent Difficulty of the Gas Turbine," published in the issue of May 3, the author points out that, whereas the constant-pressure cycle has the same theoretic efficiency, for the same degree of compression, as the constant-volume cycle of the ordinary gas engine, yet it involves a repeated handling of the gases at their minimum volume. This is a double task which the ordinary engine does not have to perform at all. Its compressed gases remain in the same locality during compression, combustion and expansion.

This repeated handling, in the constant-pressure cycle, necessarily involves increased cost of cylinder volume, increased friction and increased heat loss; and I believe that their relative importance is about in the order named.

Hence, if it is to be assumed that the gas turbine of the future must operate on the constant-pressure cycle, this appears to settle the possibility of the gas turbine competing with the piston gas engine. This is, I believe, Professor Heck's position, broadly speaking. Its truth the writer has learned from costly experience in building constant-pressure gas engines. But there is much more to the question than this, for the foregoing hypothesis rests upon three assumptions, none of which has yet been proven to be necessary.

First Assumption: That the degrees of compression must be equal for the con-

stant-volume and constant-pressure cycles. This is manifestly unfair to the constant-pressure cycle, for if the constant-volume cycle carries compression only to 100 pounds, say, it nevertheless imposes upon the engine structure a maximum pressure of, say, 350 pounds, and the entire machine must be made strong enough to stand this stress. Nor, if the engines are to expand to the same terminal pressure, is there any difference in maximum volumes to compensate. Manifestly, therefore, the two cycles should be compared upon the basis of *equal maximum pressures.*

Upon this basis, the constant-volume cycle (that of the ordinary gas engine) would have a theoretic efficiency of 44.5 per cent. while that of the constant-pressure cycle would be over 60 per cent., assuming the pressure stated above. If the actual efficiency of the cycles be taken as naturally proportional to these figures, that of the constant-pressure cycle would be over 35 per cent. greater than that of the constant-volume cycle. In other words, the constant-pressure engine might suffer practical losses 26 per cent. greater than those of the ordinary engine, and yet be of net efficiency equal to it. Indeed, the comparison can be stated more strongly yet. If the actual efficiency of the ordinary engine be one-half its theoretic efficiency, out of every 100 B.t.u. received it would actually convert 22 into work, losing also 22 of its theoretic possibilities, 44. But the theoretic possibilities of the constant-pressure cycle being 60 B.t.u., it might waste 38 of them and still come out just even with the ordinary engine. There is strong probability that it may be practicable to build within this limit.

Second Assumption: That the gas turbine must necessarily operate upon the constant-pressure cycle. This question cannot be discussed adequately without going into various constructive problems not in place here. But I wish to record my belief that the successful gas turbine will not, at least usually, utilize the constant-pressure cycle.

Third Assumption: That a gas turbine cannot overcome the difficulty of handling unusually large volumes any better than can a piston gas engine. In view of the phenomenal way in which the steam turbine has opened up the utilization, with great efficiency, of volumes so great that the piston steam engine is overwhelmed thereby, it is scarcely necessary to call attention to the promise of the gas turbine in the same direction. Again, however, I wish to record my belief that the gas turbine will not only be able to handle large volumes with sufficient ease to overcome the fundamental objections cited by Professor Heck—which, as I said, are real and important objections—but is very likely also to warrant the extension of terminal pressures into subatmospheric regions.

While we cannot, of course, literally "condense" gas-turbine exhausts, as we do steam, into volumes several hundred times smaller than before, yet the application of cold at lower pressures than atmospheric may none the less prove profitable. For it must be remembered that the piston gas engine suffers at the top of its cycle the same degree of inferiority to the steam engine which it does at the bottom. That is to say, at the top of the cycle the gas engine gets only a doubling or trebling of volumes or pressures of the "feed"—the charge pumped to top pressure. Yet on this very slim margin of profit, compared to the thousandfold increase in volume of feed enjoyed by the steam engine, it competes with the latter most successfully. Properly handled, that is, by a turbine, there is no fundamental reason why it may not ultimately do as well at the lower end of the cycle.

Neither the difficulties in expanding hot gases adiabatically in nozzles, reported by Doctor Lucke, nor the cyclic obstacles referred to by Professor Heck appear to me to constitute competent reasons for doubting the construction, in the near future, of a successful gas turbine. As to the often mentioned difficulty of getting a turbine to withstand flame, or near-flame, temperatures, I believe that to be quite irrelevant. The successful gas turbine will handle fluids no hotter than those in a steam turbine using moderately superheated steam. Considering the difficulties due only to temperature, which we experience in the use of even these standard machines, it seems to me futile to talk of building a turbine to stand gases from 1000 to 2000 degrees hotter. And it is quite unnecessary to try.

SIDNEY A. REEVE.

New York City.

Foundation Stresses

In a recent issue of this paper under the heading "Horizontal vs. Vertical Gas Engine," John S. Leese gives some calculations and figures on stresses to which an engine foundation is subjected, with which I cannot agree. Mr. Leese says:

"All forces have equal and opposite reactions, and a mean pressure of 80 pounds per square inch acting on a 24-inch piston in a single-acting horizontal engine has to be resisted by

$$\frac{0.7854 \times 24^2 \times 80}{2240} = 16 \text{ tons}$$

practically acting continuously on the foundation; or, if the explosive pressure be 320 pounds per square inch, 64 tons is the resistance needed."

Certainly "all forces have equal and opposite reactions," but it is hard to see how the reaction of the explosion ever should take place in the foundation. The engine frame alone is subject to these tremendous strains which are the results of the explosion, and it is at the crank shaft, where the opposite reaction occurs and where it is turned into useful work. But even though the foundation has not to stand as heavy a strain as indicated in Mr. Leese's article, it is nevertheless taxed to its limit by two minor reactions, and the local condition of the ground should always be made an object of careful study, where the erecting of a large gas engine is contemplated.

Take the above example of a 24-inch, single-cylinder, horizontal engine, which, I judge, must be about a 150-horsepower engine running at 140 revolutions per minute. The acceleration forces can be estimated closely enough by taking results obtained from tests on similar engines; in this case they will amount to about 50 pounds per square inch of piston area, hence the total force will be $0.7854 \times 24^2 \times 50 =$ about 22,600 pounds Of course, accurate calculations can be made only when all the details of the moving parts are at hand. This force would be acting continuously on the foundation, if the engine were not balanced at all, which is sometimes the case with vertical engines, while horizontal engines are always provided with balance weights of some kind. But as there is usually only a small space available between the main bearings, little more than about 50 per cent. of all the acceleration forces can be equalized by providing balance weights; the rest, say 10,000 pounds in our case, will act on the foundation, changing from positive maximum to zero and then to the negative maximum during one-half of a revolution.

In addition to this there is a second but minor force of reaction to which the foundation is subjected, due to the transmission of power by means of the belt. Assuming the diameter of the pulley to be 7 feet, the tension in the belt will be

$$\frac{150 \times 33{,}000}{3.1416 \times 7 \times 140} = \text{about } 1610 \text{ pounds}$$

which will have to be added to the acceleration forces when they act in one direction and subtracted when they act in the opposite direction. Adding these two forces, 10,000 + 1610 = 11,610 pounds, which is the total stress that has to be resisted by the foundation. The fact that the explosions take place in the engine cylinder, thus driving the engine, has nothing to do with the phenomena here discussed, as they would occur regardless of how the power might be applied. It makes no difference in foundation stresses whether the power is generated in the cylinder by combustion or whether the engine is driven by a belt from some extraneous source, provided the engine be substantially built and of liberal dimensions, preventing vibrations due to excessive deflection of one or several of the engine parts.

W. A. ABEGG.

Los Angeles, Cal.

Readers with Something to Say

Accident to a Corliss Engine

One of the engineers in a plant which operated continuously found upon reporting for duty that the valve gear on the crank end of the Corliss engine was not working properly. Investigation showed that the cast-iron bonnet which supports the valve stem was broken at both top and bottom, as shown at *A* and *B*, Fig. 1. As the valve stem contained sufficient metal to make it extra strong, it did not fail under this severe test. The engine was shut down, the valve gear disconnected and the bonnet removed, the latter being utilized as a pattern from which to cast another, which was finished and installed as soon as possible.

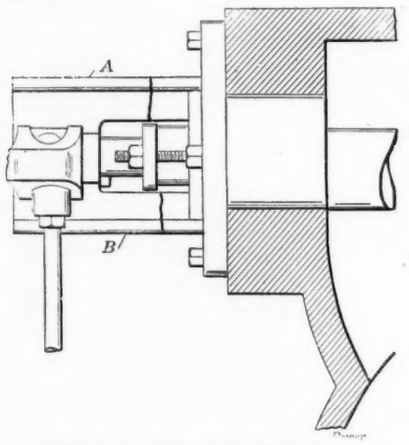


FIG. 1. CRACKED BONNET

A careful examination of the whole gear disclosed a crack in the head-end bonnet in almost the same relative location as the one in the crank end, but before it came apart a clamp was applied, as shown in Fig. 2. Holes were drilled in the clamp corresponding to those in the side of steam chest, the short cap screws which formerly held the bonnet in place were replaced by longer ones as shown at *C* and *D* and a bolt put through ears on each side. Although this prevented adjustment of the valve-rod stuffing box, it enabled the engineer to get started after a delay of nearly two days.

It seems that the bonnet must have been strong enough for all legitimate purposes, especially as the fractured metal showed a clean break with no sign of having been previously broken. It is possible that mismanagement caused the trouble. Suppose that when attempting to start the engine, the engineer did not admit steam enough to pass the outside center; in other words, with the crosshead as far away from the cylinder as possible, the crank stopped on the center. The engine being fitted with a powerful device for

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words, wanted.

turning the flywheel by hand under such conditions, and being anxious to get the machinery in motion, the engineer may have operated this device while the throttle valve was open. In the meantime steam would have collected in the steam chest and cylinder, and the crank having barely passed center with full pressure acting on the piston, the latter would start with a strong jerk very different

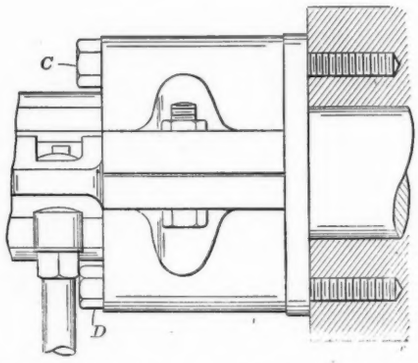


FIG. 2. BONNET WITH CLAMP ATTACHED

from its usual motion. With the steam valve held to its seat by boiler pressure and requiring considerable force to move it, a sudden shock as above described would have caused something to give way, which in this case proved to be the bonnet.

After the valve gear had been repaired and all parts connected ready for use,

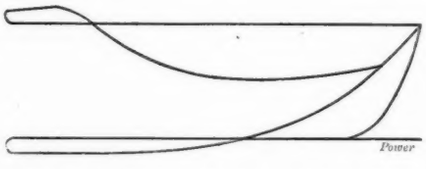


FIG. 3. DIAGRAM TAKEN WITH VALVE REVERSED

steam was admitted, but the engine did not run smoothly and failed to furnish the required power. An indicator was applied and the diagrams shown in Fig. 3 were secured. Casual examination of these seems to show negative pressure, but careful measurements with a planimeter gave a mean effective pressure of about two pounds for the right hand, and eight pounds for the left hand, or an average of five pounds for a complete revolution. This would not be sufficient to run the engine and shafting, but the main pulley is fitted with a clutch; hence, none of the shafting was running because this clutch was thrown out, therefore this mean effective pressure of five pounds was enough to give the engine and main belt full speed.

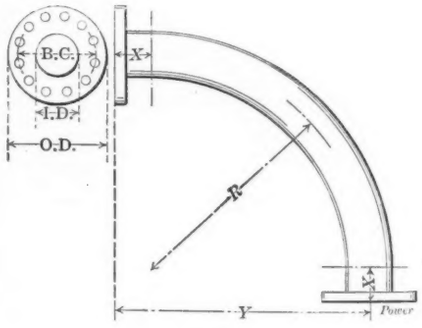
Each steam valve on this engine is driven by a T-head on the valve stem; hence, they are removed by taking off the bonnets on the side opposite to the valve gear, and drawing them out without disturbing the gear. When the crank-end valve was replaced after the repairs were completed, it was reversed by mistake and remained open during the whole stroke, as the diagram shows. After it had been properly inserted, another set of diagrams was taken and showed satisfactory results.

W. H. WAKEMAN.

New Haven, Conn.

Pipe Bends

The pipefitter of a number of years ago was accustomed to bend pipe because he was unable to obtain fittings to meet his needs. We at the present time occasionally bend pipe for this rea-



STANDARD BEND

son, but more often for other considerations which he never thought of, such as expansion, frictionless joints, etc.

Bends are better able to withstand high pressures than any kind of fitting. They also take up expansion much better and give less trouble than expansion joints.

In making bends, certain rules should be observed. Referring to the sketch, the radius *R* should be at least five times the diameter of the pipe, and more if possible, as it decreases the friction and increases the flexibility; that is, the amount the bend will close or open without

rupture. This not only refers to quarter bends but to all bends. The distance *X* is the amount of straight pipe which must necessarily be on the ends of all bends in order to thread them or make the joint. The table gives the smallest advisable amount that may be allowed for this distance but these values can be increased to any length.

The distance *Y* from the center to the face of the bend is, of course, the sum of *R* and *X* and a great many engineers and steamfitters give this measurement only, letting the manufacturer choose the radius and tangent.

The size of the pipe and description, whether standard or extra heavy, should always be given; and in regard to this I believe a great many make a mistake when they order bends made from extra-heavy pipe. The weak part of a bend is the joint or the manner in which it is fastened at the ends, and as we increase the thickness of the pipe we decrease the flexibility or spring of the bend.

For this reason I would advise the use of standard-pipe bends unless the conditions are unusual.

The following tests made by a prominent manufacturer will probably make this point clearer: An 8-inch quarter bend made from standard-weight pipe with a 40-inch radius and fitted with extra-heavy cast-iron flanges sprung 1⅛ inches when one of the flanges broke. An 8-inch quarter bend made from extra-heavy pipe, with the same radius and working under exactly the same conditions, sprung only ¾ inch when the flange broke. This showed that the standard bend was the stronger.

SIZES OF PIPE BENDS.

Size of Pipe, Inches.	Radius, "R."	Tangents, "X."	Length of Pipe in Bend of 90°.
2½	12½″	4″	2′– 3¾″
3	15	4	2′– 7¾″
3½	17½	5	3′– 1½″
4	20	5	3′– 5½″
4½	22½	6	3′–11½″
5	25	6	4′– 3½″
6	30	7	5′– 1½″
7	35	8	5′–11″
8	40	9	6′– 9″
9	45	11	7′– 8¾″
10	50	12	8′– 6½″
12	60	14	10′– 0½″

If flanges are desired on the bend, the *I D* (inside diameter) and *O D* (outside diameter) should be stated when ordering, as well as the *B C* (bolt circle) and number and size of the holes.

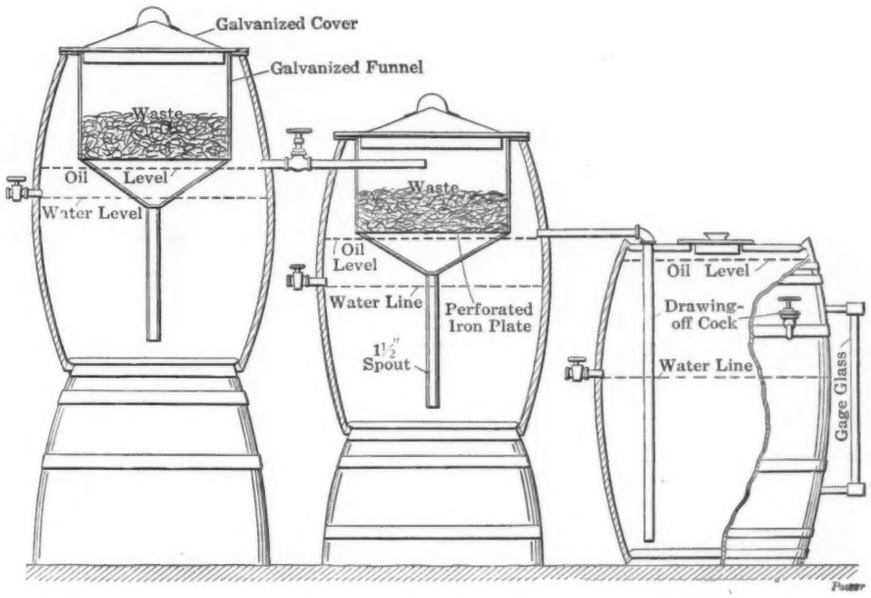
Bending a piece of pipe naturally weakens it, but with the radius given in the attached table the bend is from 15 to 20 per cent. stronger than the threaded joint. Welding or shrinking on steel flanges greatly increases the strength of the joint, but screwed joints are strong enough for any of the pressures we meet with in ordinary practice.

H. G. SCHULER.

Kansas City, Mo.

A Homemade Oil Filter

The homemade oil filter shown in the accompanying illustration has been found by an actual test of two years to be very efficient.



OIL FILTER MADE FROM BARRELS

It is made of empty barrels and other scrap material and performs its duty as well as any costly filter.

In almost any plant enough discarded material can be found to make a filter of this kind, and if the engineer is handy with the soldering iron the services of a tinsmith will not be required to make the funnel and covers.

C. F. HALL.

Yazoo City, Miss.

Running Corliss Valve Gear Noiselessly

Many men in charge of Corliss engines are apparently painstaking and particular regarding the care and operation of the equipment under their charge, excepting the valve gear. The writer has entered a great many engine rooms and found well kept machinery operating smoothly and quietly, with many visible evidences of care on the part of the engineer, yet with the valve gear chattering and rattling.

In many cases, of course, the noisy valve gear is due to lack of pride or to neglect on the part of the engineer. But there are more cases perhaps where the engineer has never realized that with a little patient and well directed effort this important part of the engine can be made to run almost without noise. Once having felt the satisfaction and pleasure of efforts thus rewarded, many who are now satisfied or indifferent would become enthusiastic on the subject.

In some instances by simply keying up the lost motion a great improvement would be effected. In this connection it is of first importance to make certain that the eccentric and reach rods are free from lost motion at the rocker arm, as a little looseness at this point reverberates loudly through the frame.

But there are other causes of a pounding valve gear not susceptible to this treatment, a poor fit of the wristplate on its bearing being a common cause. Frequently new engines develop this defect in their initial trial. A little lost motion at the center will be multiplied at the rim and may be seen by standing at the end of the valve gear and watching the vibrations of the wristplate at each stroke. Under these conditions the wristplate will ring or chatter badly. This can be cured only by bushing and fitting in a proper manner. The skeleton type of wristplate is a great improvement in this respect over the disk type and engineers having to do with the purchase or acceptance of an engine with the disk type should not accept one with the above described fault.

The next thing in importance as contributing to noisy operation is "side lash," or a lateral motion of the rods on the pins. Some builders make provision for taking up this lost motion by cutting the pins a trifle short and shimming out with circular paper liners between a flange washer and the end of the pin. Few valve gears will run noiselessly unless cared for in this respect.

As there is very little movement in the lower ends of the dashpot rods they may be keyed up quite snugly, and with these free from lost motion at both ends the steam hooks can be set quite closely. This is desirable, as when a hook is allowed excessive travel, a disagreeable noise is plainly audible as it engages the steam arm. Of course, care must be

taken not to set the hook dangerously close.

Owing to their design, some hooks resist very stubbornly attempts to make them run noiselessly. It is essential that they fit well on their pins, both reciprocally and laterally. Grease applied by means of a compression grease cup in the pin bearing acts as a deadener of sound. The leather buffer inside the hook should be as thick as possible, allowing a safe hold for the hook. Frequently leather can be dovetailed into the rear side of the hook in such a manner as to strike against the pin holding the spring thus forming a srot of additional silencer, but this is not always necessary. If a click occurs at the time the hook strikes the knockoff block, the substitution of a fiber block will nearly always cure it. This style of knockoff block wears indefinitely and is considered by many builders as superior to steel.

Compression in the cylinder aids in the attainment of a smooth-running valve gear for the reason that it tends to equalize the pressure on the steam valves, thus decreasing the friction due to boiler pressure in the steam chest. The writer does not remember having seen this point touched upon in the discussions about compression, although it will, perhaps, be admitted as of some importance.

F. C. HALLY.

Yazoo City, Miss.

Device for Inserting a Valve Stem

Often when inserting pump valves or other valves of a similar type, more or less trouble and inconvenience are experienced in getting the valve stem to catch the thread. This is on account of having to resist the pressure of the spring while at the same time turning the stem, and this often has to be accomplished while reaching through a handhole. Therefore, if a number of valves are to be inserted, the work will be facilitated by temporarily compressing the spring in some way.

SPRING IN POSITION

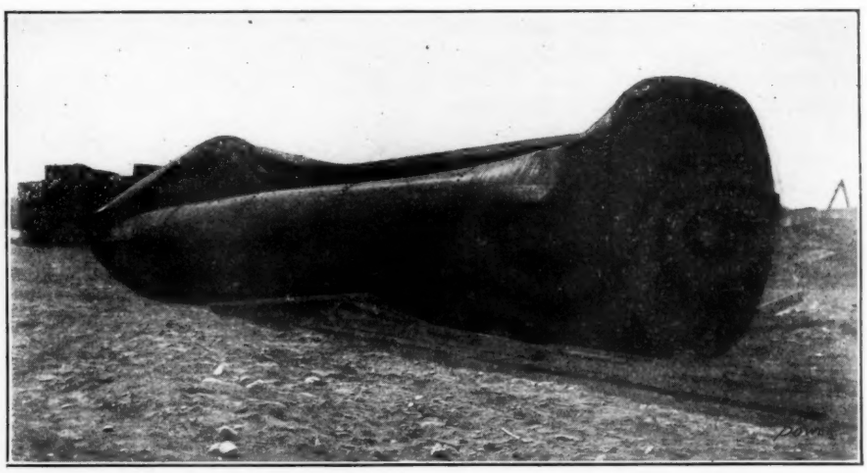
The accompanying sketch shows a very simple and handy means of doing this. The flat piece of wrought iron *A*, about 1/16x½ inch, is bent into the form of a rectangle with the ends not coming together on the fourth side. These ends are caught under the spring and the opposite side slipped over the head of the valve stem as shown. The stem can then be quickly and easily turned in and the piece of wrought iron as easily slipped off.

O. W. MIDDLETON.

Chicago, Ill.

Collapse of a Cylinder Tank

The accompanying photograph shows a cylindrical tank which collapsed in the plant of Zinsser & Co., of Hastings-on-Hudson, N. Y. The accident was due to the attendant not following instructions and allowing cold water to enter the tank while it was full of hot vapor. This probably created a partial vacuum which the tank was not designed to withstand.



COLLAPSED TANK

If any readers of POWER have any other theories to offer as to the cause of the failure, I should like to hear of their views.

H. SCHNEIDER.

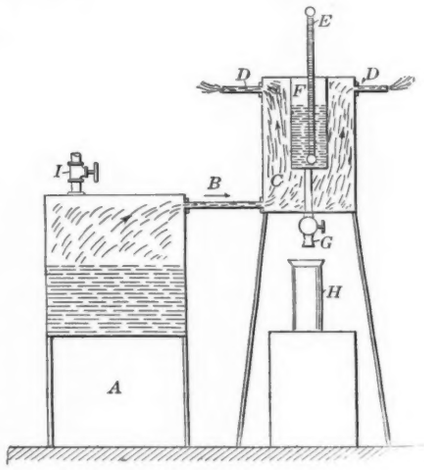
Hastings, N. Y.

Viscosity of Oils

The viscosity of oil is closely related but not proportional to its density. It is also closely related and in many cases inversely proportional to its lubricating qualities. These relations are not the same at ordinary temperatures as at high temperatures; therefore viscosity tests should be made at a temperature as near as possible to that at which the oil is to be used. A very common method is to take the viscosity as inversely proportional to its flow through a standard nozzle, while maintained at a constantly diminishing head and constant temperature. As the viscosity of water is nearly constant for all temperatures, it furnishes a good standard for comparison.

A simple apparatus, shown in the sketch, can be constructed easily and comparative results obtained. The tank *A* is partly filled with water through valve *I*. The water is heated by a blow torch or some other suitable means, and the steam passes through the tube *B*, into the chamber *C* and around the compartment *F*, containing the oil and the thermometer *E*. When the operating temperature of the oil has been reached, and kept fairly constant, valve *G* is opened and a flask *H* is filled to a certain hight, the exact time of flow being noted. This is repeated several times with each oil and the average obtained.

When the exact periods for filling the flask *H* to the given hight are obtained for the different oils to be tested, also for water, the comparative viscosity may be obtained by dividing the time of flow of the oil by the time of flow of the water. For example, it requires 102 seconds for a certain quantity of cylinder oil to flow through the nozzle *G* at a temperature of



APPARATUS FOR TESTING VISCOSITY

212 degrees, and it required 29 seconds for the same quantity of water.

$$Comparative\ viscosity = \frac{102}{29} = 3.51$$

The flash and ignition point can be found in the following manner: Place about half a pint of oil in a porcelain evaporating dish and gradually heat. As the temperature rises apply a small flame from a pine stick, about ½ inch from the surface, until a flash is noticed to skim over the oil. At this stage note the temperature which will represent the flash point.

The oil can then be further heated until it will ignite of its own accord; this temperature can be taken as the ignition point.

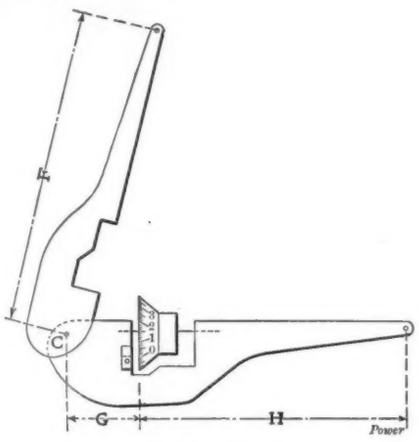
Do not place the thermometer directly in the oil but rather in a test tube containing mercury; this will lessen the danger of breaking it.

L. J. SCHRENK.

Detroit, Mich.

A Homemade Planimeter

There are many cases where a planimeter would save time and labor, but the amount of work is not sufficient to pay for its initial cost. The planimeter I constructed, a sketch of which is shown, had no cost at all, the material consisting of a few pins, a cigar-box cover and half of a common thread spool.



PLANIMETER

The arms were made from the box cover; cutting out a space for the spool so that the axis of the spool, the tracing point, and the pivot *C* are in the same straight line. The spool is held in place by two pins which makes the friction of the wheel very small. The distance *G* is made as small as possible and *F* as long as is convenient. This gives greater roll to the spool and permits the divisions being made larger so that they are more easily read. The tracing point, also made from a pin with the head downward, may be set at any convenient length.

The wheel was graduated by tracing over known areas and the amount of roll for each square inch marked on the scale. These divisions were then divided into ten equal parts, thus making the instrument read to 1/10 square inch.

The cost of making such a planimeter is a minimum and if a little care is exercised in graduating the scale, fairly accurate results may be obtained.

J. E. ROCK.

Lansing, Mich.

Induced Draft Trouble

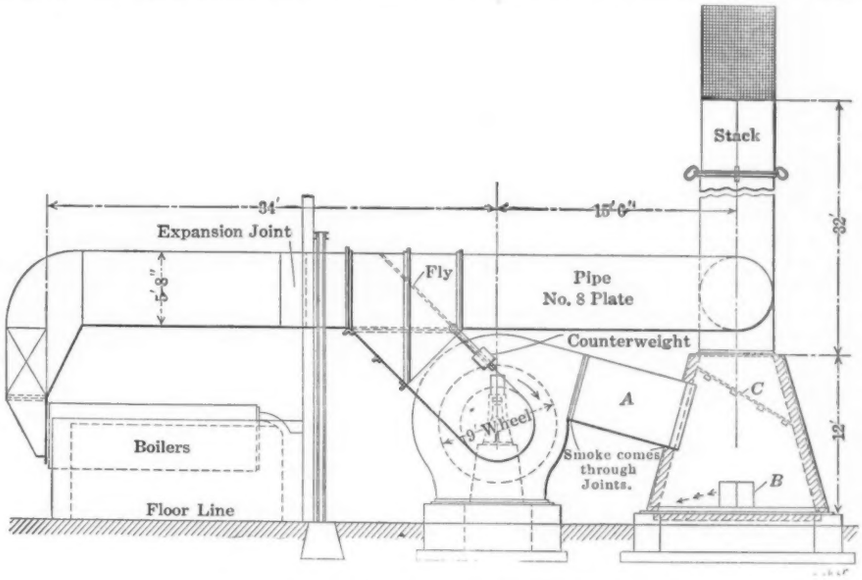
The writer recently took charge of a steam plant in which there were seventeen return-tubular boilers placed in two batteries of eight and nine respectively, the former consisting of five 60-inch and three 54-inch boilers 16 feet long. On account of damage to the smokestack of this battery it was decided to install an induced-draft system. This consists of a 7x7-inch vertical engine direct connected to a fan 9 feet in diameter with a 4-foot face. The engine varies in speed as follows: At 100 pounds pressure it makes 190 revolutions per minute; at 80 pounds pressure, 135 revolutions per minute, and at 60 pounds pressure, 105 revolutions per minute. The engine was supposed to run 300 revolutions per minute at 100 pounds pressure but 190 was the maximum speed obtained.

As the draft was too poor at this speed it was decided to install a more powerful engine, so that the fan could be speeded up to 300 revolutions per minute. A 9x14-inch engine of another make was procured and a 10x24-inch pulley keyed to the shaft; a similar pulley was also keyed to the fan shaft. The first engine was disconnected from the fan and the new one belted on. The governor on the latter engine was set at 300 revolutions per minute and the engine started. The results were disappointing as no better draft was obtained than in the former case. It was noticed that smoke poured from the joints in connection *A* (see sketch) between the fan and the stack, and if door *B* in the stack base was opened, smoke and ashes came out in the direction indicated by the arrows. The spark arrester *C* was removed as it was thought ashes might be held against it by pressure sufficient to choke it, but the results were precisely the same.

Here is a chance for the readers of POWER to determine the cause of the trouble and to state how they would remedy it with the least expenditure of time and money.

WILLIAM FAULTHIER.

Seattle, Wash.

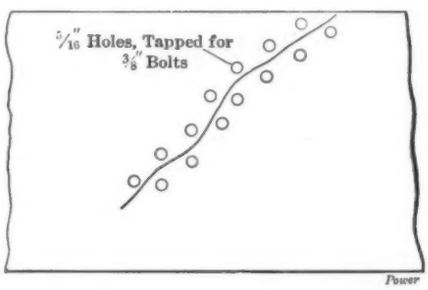


ARRANGEMENT OF INDUCED DRAFT OUTFIT

Sewing Cracks

The method of sewing cracks in iron as illustrated in the accompanying sketch has been used by the writer for a number of years and always with successful results. It is particularly applicable in cases of cracks in flue sheets.

The method is to drill staggered holes on the opposite sides of the crack and tap them, using taper taps and not tapping all the way through. This will cause the bolts, when screwed up, to expand the inside of the crack and tightly close it.



METHOD OF MENDING CRACK

Wilson, N. C. R. W. GADD.

Questions Before the House

Increasing Capacity of Steam Boilers

The article by H. Kreisinger and W. T. Ray entitled "Increasing Capacity of Steam Boilers," which appeared in the May 24 issue of POWER is useful in directing attention to possibilities of diminishing the size and cost of steam generators. It must not be thought, however, that this article and the tests referred to, which were carried out by the United States Geological Survey, have brought to light any facts not previously known about the laws connecting draft and fan power with heat transmission in connection with steam generators.

A great amount of research work has been done on this question of heat transmission in steam boilers although in most cases the tests have not been so thorough as has apparently been the case with those conducted by the United States Geological Survey. An inspection of the general index at the end of Professor Dalby's paper on Heat Transmission read before the Institute of Mechanical Engineers (London) in October of last year, will give an idea of the extent of the literature on the subject, and this index is not complete. It is a pity that many writers and experimenters on this subject did not, before writing or experimenting, make themselves more familiar with what had previously been done by others; although it would be a big task for any one person to read and digest all that has been written relevant to this subject.

As the reason why the heat transmission in steam boilers varies approximately as the square root of the draft may not appear evident, it may be useful to say a word on this point as, if a rule is understood, it is not only easier to remember but the rule is used with more confidence and satisfaction.

An elaborate treatise on the fundamental laws of heat transmission cannot be given on the present occasion but it may suffice to say that the rate of heat transmission between two fluids separated by a diaphragm (as, for example, between the hot gases and the water separated by the thickness of a tube or flue in a steam generator) can be expressed by an equation of the nature of

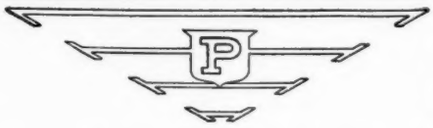
$$F = \frac{\theta}{r_1 + r_2 + r_3}$$

where,

F = B.t.u. transmitted per hour from one fluid to the other per square foot of surface. (Other units can, if desired, be used),

θ = Difference in temperature between the fluids,

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues.



r_1 = Resistance to the transfer of heat from the hotter fluid to the diaphragm,

r_2 = Resistance to the conduction of heat through the diaphragm,

r_3 = Resistance to the transfer of heat from the diaphragm to the colder fluid.

The equation, it will be seen, is of the same nature as Ohm's law for electricity and applies not only to steam generators but to surface condensers, tubular water heaters and the like.

In a steam generator under usual working conditions r_2 and r_3 are so small compared with r_1 as to be negligible or nearly so; the equation can therefore be expressed as

$$F \doteqdot \frac{\theta}{r_1}$$ ($\doteqdot$ signifies approximate equality).

The value of r_1 has been found by numerous experiments to depend greatly on the velocity, decreasing with increase in velocity; and in the case of the hot gases such as pass over the heating surface in a steam boiler, r_1 has been found to vary very approximately as the reciprocal of the velocity, so that the equation becomes

$$F \doteqdot \frac{\theta}{\frac{C}{V}} \doteqdot \frac{V\theta}{C}$$

where V is the velocity of the gases and C is a constant.

We have therefore arrived at the conclusion that the rate of heat transmission varies approximately as the velocity of the gases. But, as the kinetic energy of a fluid is proportional to the square of its velocity and as the kinetic energy must equal the energy expended in producing that kinetic energy, it follows that the velocity given to each pound of hot gas in a steam generator by the fan or other source of draft must vary as the square root of the energy usefully expended by the fan (or its equivalent). A certain irregularity is caused by the reduction in the gas velocity due to friction, but it will be seen that, generally speaking, the heat transmission would be proportional to the square root of the fan power, or the fan power would vary as the square of the heat transmission, if the weight of the gases passed through the boiler per minute were kept constant. If, however, the aggregate area for the flow of the gases is kept constant, the weight of gas passed per minute must increase with the velocity, so that the fan power varies as the cube, or third power, of the heat transmission. The product of draft and volume of gas per minute is a measure of power, and hence, as the volume per pound varies little unless with enormous drafts, the draft varies approximately as the square of the heat transmission or the heat transmission varies approximately as the square root of the draft.

Being clear as to the reasons for variation in heat transmission we can then try to benefit by applying the knowledge; but it is here that we are handicapped by want of data.

It is easy to draw up tables as given in the article above referred to; and such tables may certainly be sufficiently correct to be of service; but, having prepared the tables, we are still very far from knowing what is the best fan power to provide for in any case.

If a boiler plant is wanted to generate a certain weight of steam per hour at a certain pressure, then the question arises as to what is the best fan power to provide. To solve this problem we must consider the initial cost of the boilers, the initial cost of the fans with the engines or electric motors driving them, and the coal corresponding to the work absorbed by the fans. We must also consider the question of any variation in the boiler efficiency due to altered conditions as regards draft or arrangement of heating surface and any variation in engine efficiency due to alteration in the dryness fraction of the steam due to change in the evaporation rate. We must compare any increase or decrease in the standing charges which must be allowed for interest on initial expenditure and for depreciation, etc., with any decrease or increase in the running costs due to coal, wages, repairs, etc. We must, in fact, prepare a curve showing the variation in total annual expenditure with variation in fan power. This curve falls with increase in fan power up to a certain critical point and then rises; but the ascertaining of the critical point with reliability is a matter of considerable difficulty. The critical point is certainly not the same for all types of boiler and for all conditions. Weight is an important consideration in warships but is of comparatively little consequence on land. The importance of floor space varies under different condi-

tions; and coal (or other fuel) varies greatly in price according to locality.

The most serious difficulty arises, however, in determining how the fan power affects the initial cost of the boiler per pound of steam generated per hour and the depreciation and repair costs. Increase in fan power reduces the necessary heating surface; but a little consideration will show that the reduction in cost of boiler is not proportional to the reduction in heating surface and must vary with the type and design of the boiler. Grate area, steam-liberating surface, and thickness of tubes and plates must all receive consideration. As regards the danger of overheating of plates, little appears to have been published on this subject which is of use in the present consideration, but there is, no doubt, that the risk of trouble due to overheating increases with increase in the rate of heat transmission. This point is of special importance when the feed water contains oil. Data on the subject by those who can speak from experience would be of great value.

R. M. NEILSON.

Glasgow, England.

Blowoff Tank

In POWER for May 17 particulars are given of an accident to a blowoff tank, the cover of which was fractured, presumably when the boiler was being blown down. There have been accidents of this kind before and in one which happened a few years ago, if the writer remembers correctly, there was loss of life.

It seems that an accident of this kind should be attributed not so much to the weakness of the tank as to the insufficient area of the vent pipe. It is evident that if the outlet pipes were only of the same total area as the blowoff from the boiler the pressure in the tank would very soon equal that in the boiler. It is necessary to make the outlet area sufficiently large to discharge all of the water and steam entering it while the pressure in the tank remains low.

These tanks are not usually safe under pressure of more than about 5 pounds per square inch and are often used in places where it is undesirable to blow down directly into the drain; the practice adopted being to blow down into the tank and allow the water to cool before running it off into the sewer. The outlet to the sewer enters near the bottom of the tank and is closed when the boiler is being blown down. With any arrangement, however, it seems safest to consider the outlet to the sewer as having to discharge water only and to calculate the size of vent pipe so that it will be capable of discharging all the steam which is formed with a pressure in the tank not to exceed, say, 5 pounds per square inch.

To perform this calculation we have to determine first the rate at which water will be discharged under a given pressure through the blowoff tap. The formula

$$v = \sqrt{2gh}$$

gives the velocity of a jet of water issuing under a head h but assumes that the water is flowing in a steady and unbroken jet. The conditions which obtain when blowing down a boiler, however, are very different from this, as the water is much hotter than 212 degrees and is therefore evaporating as the pressure falls so that the jet is actually a mixture of steam and water and the weight passing the blowoff tap per minute is materially less than is given by the above formula. The shape of the blowoff tap and the resistance of the pipes and bends also restrict the flow.

Actual tests made by noting the fall in the gage glass when the blowoff was fully open showed that with a pressure of 100 pounds in the boiler about 2000 pounds per minute was the rate of discharge through a 2-inch blowoff tap, which is only about one-fourth the amount which would be given by the above formula.

Taking this figure, 2000 pounds per minute, therefore, we next have to find how much steam is formed by the reduction of pressure from 100 to 5 pounds gage pressure.

Let x equal the weight of the steam formed per pound of water blown into the tank and assume that there is no loss of heat in the process. We have, then: The total heat of one pound of water at 100 pounds pressure equals 338 B.t.u. The total heat x pounds of steam at 5 pounds pressure equals $1183x$ B.t.u. The total heat of $(1 - x)$ pounds of water at 5 pounds pressure equals $228\ (1 - x)$.

Equating, we have,

$$1183x + (1 - x)\ 228 = 338,$$
$$955\ x = 110,$$
$$x = 0.115$$

pound.

The vent pipe therefore must be large enough to discharge

$$2000 \times 0.115 = 230$$

pounds of steam per minute at a pressure of 20 pounds absolute. Rankine's approximation for the rate of flow of steam gives results which have been checked and found to agree very closely with what is obtained in practice. The approximation is

$$q = p \div 70,$$

where q equals the weight of steam discharged per unit of area per second and p equals the internal absolute pressure. The external pressure is immaterial so long as it does not exceed $\frac{3}{5}\ p$. The rate of flow from the vent pipe works out by this formula to 17.16 pounds per square inch of area per minute. We have already found that the weight of steam to be discharged is 230 pounds per minute and consequently the size of the vent pipe necessary to do this under the conditions assumed must be

$$230 \div 17.16 = 13.4$$

square inches or, say, 4⅛ inches in diameter.

In the example shown the total area of the vent pipe and outlet to the sewer is only 6.28 square inches so that the pressure in the tank must have been considerably more than 20 pounds gage pressure before it could pass all of the steam which was formed. To find the exact pressure in the tank, the calculation will have to be gone over again as the amount of steam formed at this pressure will be less than when the pressure is 20 pounds absolute. The calculation can be most readily made by a process of trial and error and it will be found that the pressure in the tank will have to be about 35 pounds absolute to give a rate of flow of steam through the outlet pipes equal to the amount formed by the reduction of pressure from 100 pounds to the pressure in the tank.

This pressure would probably not be sufficient to fracture the cover though it is higher than is quite safe for a cast-iron plate ⅞ inch thick and 2 feet, 6 inches in diameter without ribs. The calculation has been made moreover on the assumption that the outlet pipe is free to act as a vent as well as the vent pipe proper, whereas if the tank becomes full of water the outlet pipe will be covered and the calculation would then have to be made on the assumption that the vent has to discharge all of the steam. Under these conditions it is quite possible that the pressure in the tank would be high enough to burst it and it is quite likely that this is what occurred. The nature of the fracture clearly illustrates how the plate is weakened by the center manhole; the radial cracks evidently having started at the opening.

WILBUR ARNOLD.

Manchester, England.

The Selection of an Engine

Cornelius T. Myers in his discussion of the selection of an engine, in the May 24 issue, states that it is well recognized among engine builders of experience that high piston speeds mean better steam economies, for the larger the volume of steam worked through a given cylinder the smaller is the percentage of condensation therein.

Upon investigation it will be seen that this statement is incorrect.

In the first place, the given proof does not hold, for, if the engine is worked with a later cutoff than that giving the economical number of expansions, more steam is passed through the cylinder but the engine uses more steam per horsepower than it would if it were working with the economical number of expansions.

In the second place, take two engines, one of low speed, say 500 feet per minute, and the other of high speed, say 800 feet per minute, both developing 200 horsepower when working at 40 pounds mean effective pressure, and both having cylinders with the same percentage of clearance volume.

The cylinder dimensions of the low-speed engine would be,

$$\frac{33{,}000 \times 200}{40 \times 500} = 330$$

square inches in area, or about 20.5 inches in diameter. Taking the revolutions per minute as 100, the stroke would be 30 inches.

The cylinder dimensions of the high-speed engine would be

$$\frac{33\,000 \times 200}{40 \times 800} = 207$$

square inches in area, or about 16.25 inches in diameter, and, taking the revolutions per minute as 160, the stroke would be 30 inches.

Engine builders know from their own tests that, if these two engines were working at the same mean effective pressure, the larger engine would be the more economical. This may also be seen from published tests of engines.

The reason advanced for this is that with the increased cylinder dimensions the cylinder surface exposed to the steam is less, and in view of the fact that cylinder condensation is increased by increase of steam surface this seems to be the feasible explanation.

That the cylinder surface is the greater in the high-speed engine is readily seen, for the speed is increased 60 per cent.; but the surface per stroke decreases approximately only in proportion to the diameters, that is, 20 per cent.

Thus there is a choice of two engines both capable of developing the same economical and maximum powers and equally reliable; one, a high-speed, being of lesser weight, has its low cost to recommend it; the other, a low-speed, has its better economy to recommend it.

It is not only the buyer or his agent that has this choice, for the engine builder has to decide upon which engine to submit his tender, and he far too often only has the meager details of the inquiry or his knowledge of the destination of the engine to guide him.

In Mr. Miller's list of high-speed tandem-compound engines the maker *D* offered the biggest engine, at the best steam consumption and at the lowest price per horsepower. This, however, was passed over for maker *C*, who, besides not making such a good offer, was unwilling or unable to give steam consumption.

In the list of high-speed Corliss or four-valve engines the maker *D* offered the engine capable, as Mr. Myers states, of developing greater economical and maximum loads under all conditions at a lower price than maker *B*. This, however, was passed over for the reason Mr. Miller states.

Mr. Miller's final choice could also have been investigated if the various makers had been able to give the steam consumptions under the three conditions specified.

Both Mr. Miller and Mr. Myers are to be congratulated upon their contributions to this subject, for in many cases it is only considered when the results of a new plant have been disappointing, and it is then that the gas engine often makes a convert.

A. V. CLARKE.

Gainsborough, England.

Central Station versus Isolated Plant

To my mind Mr. Naylor's statements in a recent issue of POWER, in regard to Marshall Field & Co.'s plant being captured by the central-station people proves once again the almost inconceivable apathy displayed by the consumers of central-station current and, in particular, the operating engineers of isolated plants. According to a recent statement of the New York Edison Company to the Public Service Commission, their average rate for lighting was 7.13 cents per kilowatt-hour and for power 6.77 cents per kilowatt-hour.

The situation is simply this: The small consumers at 10 cents per kilowatt are forced to pay 3 or 4 cents per kilowatt more than the average, and the large consumers, who can afford to operate their own plants, and who, as a matter of fact, consume but a small proportion of the total output, enjoy the special privilege of paying 3 or 4 cents less than the average rate. In other words, the central-station people, who receive their valuable franchises by the consent of the people through their respective legislatures are allowed to use a rate discrimination of between 300 and 400 per cent. If this rate discrimination was adjusted on a fair basis between the central-station people and the public, as are railroad rates, gas rates, surface-car rates and those of numerous other public utilities, the "nigger in the woodpile" would be captured and annihilated instead of the private plant.

It seems to me that Mr. Naylor is certainly stretching his argument to the breaking point when he compares private water works and private gas plants with the private electric light and power plants. Mr. Naylor might see a ray of sunshine through his gloomy vision of the isolated plant's future in view of the fact that the extra cost of installing generating machinery in the average building is not a "million dollars or more," and especially as the engines for several months in the year incidentally act as reducing valves for the heating system. In lieu of more definite information, I presume Marshall Field & Co. buy their steam for heating purposes from an outside company, or else heat by electricity, as one reason advanced by Mr. Naylor for shutting down the plant is that they have no sidewalk room for delivery of coal and disposal of ashes.

I submit that my knowledge of Chicago plants is quite limited, but I am surprised to learn through Mr. Naylor that the element of "noise, dirt and danger" carries such weight in favor of central-station service. Why not make the isolated plant clean, quiet and safe, as a modern plant should be that is operated by a competent engineer who has the confidence of his employer, especially as discarding the electric generator units only relieves the engineer of one of the many responsibilities in connection with the modern plant. Every cloud has a silvery lining, however. The central station is a necessity and a benefit all around. But it must be compelled to play fair. In its energetic fight to displace the isolated plant, it has put the operating engineer on his guard, and consequently numerous plants are being operated with greater economy with a tendency to install a higher grade of machinery than in the past.

It is the old story of the survival of the fittest, and it is up to the operating engineers to realize and cope with the existing conditions. If they direct their concerted efforts through the proper channel, they are bound to come out victorious in the end.

HARRY J. MARKS.

New York City.

Boiler Room Ventilation

I would like to say a few words in regard to the letter by J. L. Shell in the June 14 number as he asks for the opinion of other engineers on the subject.

In the first place, keeping the boiler-room doors shut will, in a measure, keep the room temperature higher and decrease the loss due to radiation as the manager claims. But, as Mr. Shell says, the temperature would have to go to 373 degrees entirely to stop the radiation.

Now suppose the manager had Satan himself to fire in that temperature, as natural draft depends on the difference in the weight of a column of cold and a column of hot air; hot air inside the stack, and the cold air having free access to the ashpit, the devil, having considerably warmer air than normal in the fire room would get a considerably reduced draft. Also, as no fresh air came in, the resulting poor combustion due to an insufficient supply of oxygen would cause heavier loss of economy than would open boiler-room doors.

The radiation losses from the piping in the boiler room would not be 5 per cent. even with uncovered piping, but

the economy of the boiler can easily be reduced 10 to 15 or 20 per cent. by poor conditions of fire and air supply.

By using pipe covering and also having a plentiful supply of good fresh air, more coal will be saved than with closed doors and bare pipe. Some places have practically tight fire rooms, but air is forced into them and out through the stack by pressure, and the air is fresh.

The manager shows very little humanity. Also he does not appreciate an engineer. Mr. Shell will not improve his prospects nor increase the manager's appreciation of engineers by staying there. I heartily approve of his resolution to let the cleaning of fittings go until a more convenient season.

W. C. THORNE.

Vineland, N. J.

Boiler Explosions

In POWER for May 31 there appeared an article by Peter Van Brock under the heading "Boiler Explosion." It seems to me he leaves an impression which might prove disastrous if it were followed when he says that there is little or no danger of an explosion so long as the "coal tosser" keeps his water up to the mark. In the first place, he says that it is the engineer's business to see to it that the internal pressure does not exceed one-fifth of the strength of the boiler. We are perfectly willing to agree with him on this point. If we were always able to know that such conditions existed in our boilers we would never have any nightmare about boiler explosions; but, unfortunately, it is beyond the ken of man to know the exact condition of all parts of his boiler plant at all times. There are myriads of causes for the initial rupture, which is usually followed by a disastrous explosion. It may be due to contraction and expansion strains, poor workmanship, poor material, poor design, ignorance in operation and, no doubt, there are some cases where the rupture is caused by a weakening of the plates by overheating due to low water.

Brother Van Brock says that when the water level gets below the fire plate or tubes the steam gets enormously hot and dry and the pressure builds up very rapidly with an explosion as the result. On this point we ask, what is the purpose of superheaters? Is it to build up the pressure? We think not. If the pressure built up with the temperature we would still have saturated steam and not superheated steam.

Suppose that in a horizontal tubular boiler the water level falls 8 or 10 inches below the fire line. The conditions inside the boiler are not changed except that a more or less superheating of the steam has taken place without any change in pressure. The heat transfer from iron to steam is not nearly so rapid as from iron to water; consequently, the steam being unable to "soak up the heat," the plate between the fire line and the lowered water line becomes overheated, and, since steel when heated above 600 degrees Fahrenheit loses its strength very rapidly, the answer is easy. When the plate becomes too weak to stand the strain it parts, relieving the boiler of its pressure. The water contained in the boiler when relieved of its pressure suddenly becomes an explosive matter and forthwith proceeds to deface the landscape.

Years ago, probably at about the time when the ferry- and tug-boat boilers which Brother Van Brock tells us of exploded, it was customary in cases of boiler explosions to lay it all to low water, thus shielding the owners of boilers that should have been in the scrap heap and placing the blame on the engineer.

In recent years when men in charge of steam boilers became better acquainted with the physical properties of boilers and their contents, the ideas about explosions being due to low water began to fade away and more common-sense views of the matter were taken with the result that we are building better boilers, subjecting them to more rigid inspections, exercising more care in their operation, and we believe that, considering the number of boilers in use, there are fewer explosions and less loss of life and property.

Brother Van Brock says that at one time he carried 205 pounds pressure in a boiler that was allowed only 100 pounds by the inspector, and would willingly have carried another 100 pounds had it been necessary, safeguarding (?) himself by carrying 4½ inches of water over the fire tubes. In the light of the foregoing it is not hard to place the brother from the Hawkeye State.

In regard to low water, I would like to ask Brother Van Brock the following question: In the Manning, Climax, Porcupine and numerous other vertical boilers with about one-fourth or one-third of the heating surface above the water line, why is it that the steam does not become enormously hot and dry and build up the pressure to the bursting point? For example, take some of the small vertical fire-tube boilers in which the water line is not more than 4 or 5 feet from the fire, if the exposure of a plate or tube in one boiler has such a disastrous effect, why is not the same effect produced in another boiler? Again, how often do we hear of locomotive engineers being discharged for burning the crown sheets in their boilers? Is it to be supposed that the crown sheet is burned when it is covered with water? We think not. If not, why does not an explosion occur?

We should remember that low water leads to dangerous conditions and that excessive steam pressure must not be tolerated. We should refuse to operate a boiler when we know it to be unsafe. Our boilers should be thoroughly examined at regular intervals as to cleanliness, condition of fittings, setting, supports, braces, etc. A boiler explosion with high water is much more disastrous than with low water. We must not allow sudden opening of large valves. If these precautions are taken, we need not worry much about explosions, and in case an explosion does occur we will know that it was from some cause that could not be foreseen, and consequently is not the fault of the operating force.

R. L. BEVIS.

Terre Haute, Ind.

Recent issues of POWER and other technical papers have reported the wrecking of an engine by the bursting of the flywheel, resulting from a governor that failed to govern at the time most needed, and two disastrous boiler explosions from unknown causes.

Professors of expert knowledge may speak authoritatively on the cause by judging from certain of the effects visible to them. But vague speculations and theories founded thereon are not knowledge, and are of no practical value.

Shortness of water is often cited as a cause of explosions in steam boilers. It is a question if shortness of water ever was the prime cause of any boiler explosion while the water in the boiler was being depleted at a regular, steady rate.

I have seen a vertical boiler which a number of men assured me that they had seen red hot on several occasions; the engine stopping for lack of steam drew attention to the boiler. A hurried departure of all hands from several small factories in the vicinity followed each time. The boiler seemed to be no worse for its experiences. An old manufacturer in Detroit assured me that he had tried on several occasions to see if his boiler could be ruptured through shortness of water and was satisfied that it could not.

JOHN W. PAYLER.

Detroit, Mich.

Lubricator Remedy

Referring to the remedy for lubricator trouble suggested by Mr. Wentz in the May 31 issue, I wish to say that I have used the following with good results:

After filling the lubricator, blow out the water in the glass thoroughly, cut off steam, take off the cap and pour in a little soapy water. Any kind of soap will do; I have used common laundry soap. I find that this remedy gives better results than the use of glycerin or salt.

Probably many readers have used this remedy. It is recommended to those who have not.

MARTIN MCGERRY.

Hilton, N. Y.

Oil Mill Superintendents Convention

The seventeenth annual convention of the Oil Mill Superintendents Association was held at the Menger hotel, San Antonio, Tex., on June 7, 8 and 9. Most of the members were present, and an enjoyable time was spent by all.

The convention was called to order by President T. J. McNulty, of Brookhaven, Miss. A number of interesting papers on engineering and other subjects pertaining to the operation of the mills were read during the three days' meetings, and much benefit was derived by the members from the practical points brought out in them and the discussions which followed. Some of the papers concerning the engineering side of the question were as follows: "Packing, Its Use and Abuse," by W. E. Sanders; "Indicating and Valve Setting," by J. C. Newberry; "Boilers and Their Care," by Walter Leonard; "Rope Driving," by W. B. Hosford.

Effective use was made of the blackboard in illustrating the subjects touched upon by the papers, especially in explanation of the indicator diagrams, and from the interest shown by the members in this subject it was plain to see that all thoroughly appreciated the value of the indicator and the necessity for its use in their plants.

The supplymen's organization, which is connected with the association, is only two years old, this being the second year that they have made an exhibit. This association is known as the Oil Mill Machinery Manufactures and Supply Association, and from the showing they have made this year it is a "husky" youngster, and sure to grow rapidly. At present there are 43 members, and a number of new applications on file. Those of the members who had exhibits of their products this year were: Philip Carey Company, Jenkins Brothers, Johns-Manville Company, Peerless Rubber Manufacturing Company, Cleveland Rubber Works, Crandall Packing Company, Buckeye Iron and Brass Works, Strong, Carlisle & Hammond.

The new officers elected for the coming year were: President, F. E. Voorhies, LaFayette, La.; vice-president, J. C. Newberry, Gonzales, Tex.; secretary-treasurer, B. C. Newberry, Lyons, Tex., reelected; assistant secretary, Mrs. B. C. Newberry, Lyons, Tex., reëlected.

The State vice-presidents elected were: Texas, Ed Taylor, San Marcos; Arkansas, Guy Conley, Paris; Mississippi, W. R. Crout, Hazelhurst; Louisiana, F. A. Parodi, Bastrop, reëlected; Oklahoma, G. C. Reed, Stroud; Tennessee, Charles E. Graham, Memphis, reëlected.

The officers of the Manufactures and Supplymen's Association for the past year were: President, F. M. Smith, Dallas, Tex.; vice-president, A. C. Langston, New York; secretary-treasurer, W. H. Marshall, Chattanooga, Tenn. When the time came for electing the officers for another year, all of the present ones were reelected by acclamation. The next convention will be held at Houston, Tex., in June of next year.

Baltimore High Pressure Fire Service

The accompanying view shows one of the three new high-pressure fire-service pumping engines, built by Allis-Chalmers Company, to supply the high-pressure fire-protection lines of the city of Baltimore, Md. The three pumps are complete in the shops and are awaiting the completion of the new pumping station which is being built by the city.

These pumps will take their supply from the regular city lines, but additional provisions have been made for a supply direct from the harbor.

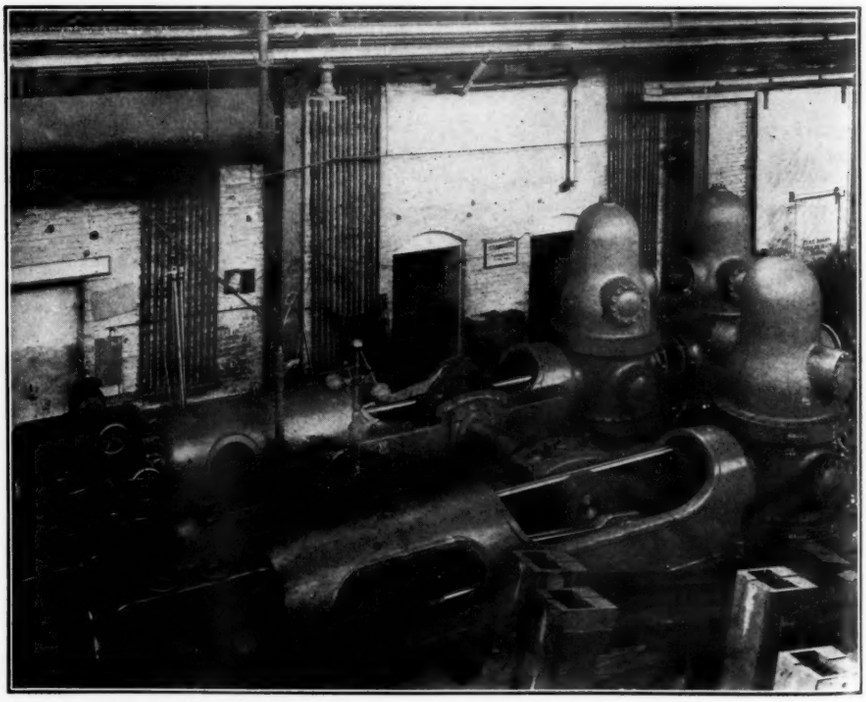
The pumping engines are of the horizontal, twin-duplex, crank-and-flywheel type with steam cylinders 22 and 22 by 36 inches in size and pump plungers 13¼ inches in diameter. Each pump has been designed to deliver 3000 gallons of water per minute against a total head of 150 pounds, but they are also capable of pumping against a maximum pressure of 300 pounds per square inch.

The type of machinery selected by the city of Baltimore is interesting, as it differs from that used by other large cities for fire protection.

The city of New York has pumping stations equipped with Allis-Chalmers motor-driven centrifugal pumps. Philadelphia, in which city the first high-pressure system was installed, decided upon geared triplex pumps, driven by three-cylinder, vertical gas engines. The city of Philadelphia has enough independent sources of gas supply to be convinced of its absolutely reliability. Both of these systems have been extremely satisfactory in their operation.

The next large city to install high-pressure fire-protection apparatus was San Francisco, Cal., immediately after the earthquake and fire which destroyed all of the business section of the city. Steam-turbine-driven centrifugal pumps were selected for both the land stations and the fire-boat equipments. Oil is used for fuel under the boilers.

When the new system is in service the insurance rates in Baltimore will be much lower than they are at present and a great conflagration will be practically impossible.



ALLIS-CHALMERS PUMPING ENGINE FOR HIGH-PRESSURE FIRE SERVICE IN BALTIMORE

Issued Weekly by the
Hill Publishing Company
JOHN A. HILL, Pres. and Treas. ROB'T MCKEAN, Sec'y.
505 Pearl Street, New York.
150 Michigan Avenue, Chicago.
6 Bouverie Street, London, E. C.
Unter den Linden 71—Berlin, N. W. 7.

Correspondence suitable for the columns of POWER solicited and paid for. Name and address of correspondents must be given—not necessarily for publication.

Subscription price $2 per year, in advance, to any post office in the United States or the possessions of the United States and Mexico. $3 to Canada. $4 to any other foreign country.

Pay no money to solicitors or agents unless they can show letters of authorization from this office.

Subscribers in Great Britain, Europe and the British Colonies in the Eastern Hemisphere may send their subscriptions to the London Office. Price 16 Shillings.

Entered as second class matter, April 2, 1908, at the post office at New York, N. Y., under the Act of Congress of March 3, 1879.

Cable address, "POWPUB," N. Y.
Business Telegraph Code.

CIRCULATION STATEMENT

During 1909 *we printed and circulated* 1,875,000 *copies of* POWER.

Our circulation for June, 1910, *was* 139,000.

July 5..... 34,500
July 12..... 34,500

None sent free regularly, no returns from news companies, no back numbers. Figures are live, net circulation.

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Power and The Engineer

Editorial

The Institute of Operating Engineers and Existing Organizations

The following letter addressed to an officer of the National Association of Stationary Engineers who declined to take an active interest in the Institute for fear that it might detract from the older association, is interesting as developing more fully the character and purposes of the Institute and its real relation to existing organizations:

The National Association of Stationary Engineers is a fraternal organization, with ritual, signs, tokens and passwords. Its meetings, smokers, picnics, balls and conventions afford opportunities for members of the craft to extend and strengthen their acquaintance, to discuss the doings in the profession and to listen to a line of salutary talk from the leaders, to have a good time, including that significance of "good" which includes beneficial, and for the stronger personalities to achieve preferment and distinction.

Its lectures, discussions and prize contests are all good, in that they encourage men to think, to debate, to contest in intellectual achievement and induce habits of thought and study. But the educational work which it does is incidental. It begins nowhere and leads nowhere (except as all education, however desultory, leads upward). A man may be a member of the National Association of Stationary Engineers all his life without being able to do an example in decimal fractions.

As a fraternal society the National Association of Stationary Engineers is a helpful influence in the field and has done, and will continue to do, a lot of good along the lines projected by its founders.

The proposed Institute is a college with classrooms all over the country, in night schools, in homes, in college extension courses, in the institutions which have already been provided and in those the opening or establishment of which it will inspire, where men may learn as they earn. Its laboratories are the engine and boiler shops and the power plants of the country. Its curriculum will be such that when a man has mastered it he will have all that a technical graduate has of knowledge applicable to power-plant operation, and will not have to plead for primers and story books because he cannot read the standard literature of his business. He will have years of practical experience, acquired at the same time that he was acquiring his book lore, and developed and ripened by the application of that book lore as it was attained. And he will have such an education as will enable him to meet cultured people upon their own plane, and to take a gentleman's interest in the doings of the world.

When he passes the grade of a mechanician or hand workman, and has the fullness of years, experience and study necessary to constitute him one of the highly specialized and multifariously trained beings that the real operating engineer according to the Institute's standard will be, he becomes a full-fledged member of the Institute and receives a certificate, which can be made to mean more than a degree of mechanical engineering from any institute in the land to a man whose life work is to be the operation of power plants.

The time is not so far distant when anybody who had money enough to buy a pair or two of foceps and the strength to use them could be a dentist. If one wanted to get a tooth pulled, he usually went to the barber. Now, dentistry is a profession. Its members are well remunerated and can afford refinements, conforts and advantages that the mechanic cannot offer to his family. But nobody can be a dentist who has not graduated from a college of dental surgery.

The vocation of operative engineering is in much the same slack unorganized chaotic condition that dentistry was a hundred years ago. A man takes a job to run an engine for $1.50 a day because he cannot get a job to lay bricks at $4 a day, and he becomes "the engineer." And when the engineer is spoken of the popular conception does not jump to the thoroughly trained and highly specialized individual whom we know as the responsible engineer in charge of complicated power plant, but to a slouchy member of the laboring class who makes clean money by working in a grimy steam plant and who is not content to take the money home with him and leave the grime behind. It is true that a lot of the operating engineers are gentlemen in every sense of the word. They dress like gentlemen, behave like gentlemen, talk like gentlemen, practice the amenities of life and are agreeable social companions. But these are weighted down by a mass who have never got, and never will get, beyond the mere hand worker or crafts-

man stage, and when you say engineer the man on the street thinks of a paper cap, a monkey wrench and an oil can and not the indicator, gas analysis and power-plant economics.

When a man holds a certificate of membership in this Institute, it will mean that he is one of the first kind of men. We will make the term "operating engineer" mean something, and something more than a hand laborer, and while it is not expected to restrict the practising of operative engineering to those holding the degree of the Institute, as the practice of dentistry is confined to those holding the degrees of the colleges of dental surgery, we can make it mean so much, and so demonstrate to employers that this kind of a man is worth so much more than a mere laborer that operating engineers will be employed as heads of departments and at salaries commensurate with their responsibilities and preparation, and the Institute will be the natural source of supply for such men. Employers, commissions in charge of public work, and others are already coming to it for suggestions as to high-class men suitable for the large opportunities which they have to offer.

The Institute would naturally exert its activities in every legitimate way toward the amelioration of the condition of the workers and attendants around the plant —the men on watch in the boiler and engine room, who would naturally be its apprentices and journeymen—to a reduction of their time to a reasonable working day that they might have time and capacity left for self-improvement, to an improvement of the conditions surrounding their employment to include as much of comfort and convenience as is consistent with the character of the work, to induce a better class of young men to look to the vocation as a career and encourage them to stay in it after they get started.

The Institute will be to the vocation what the civil, mechanical, electrical and mining engineering societies are to those professions. It will have meetings, as do these great national societies, at which papers of real value will be presented and discussed, giving to their authors an opportunity to become known and distinguished along the lines of their particular research or practice, and to the profession the results of that study and experience. Their proceedings would become as important and valuable in this particular field as are the proceedings of the learned societies in the fields of their own activities.

In addition to prescribing for its undergraduate members, courses of study adapted to the several grades, the Institute would exert its activities in the direction of cultivating opportunities to pursue these lines of study. Advantage would be taken of the opportunities offered by such institutions as the Franklin Union at Boston, and various similar institutions in other cities, of the expressed willingness of a number of technical schools and colleges to place their facilities at the service of the working man when a practicable plan therefor is evolved, to procure courses in night schools, correspondence schools, Y. M. C. A. classes, etc., especially planned to carry out the requirements of the curricula and to meet the needs of the advancing students, and in general to do anything that it can do to systematize the work of getting education that will be helpful to the mechanic.

The interest and promised support and coöperation of prominent educators toward this end is an encouraging sign.

You would not expect a young man to give up his membership, or lose his interest in the National Association of Stationary Engineers because he took a course in power-plant engineering in the Franklin Union, would you? On the contrary, if every member of the National Association of Stationary Engineers in Boston would take such a course, we would have a higher and better standard of membership when they got through, and if with this technical instruction there could be combined that indefinable something which comes with education, and the scholarly association of man with man, we would have gone far in raising the plane of the membership, as we have been talking and writing of raising it and seeing it raised for the last quarter of a century.

You Will Never Know

In reporting the boiler explosion which recently occurred at the Midvale Steel Works, Philadelphia, Penn., in which two men were killed and several seriously injured, one of the daily newspapers assigned the following cause for the disaster:

"The cause of the explosion, according to officials of the plant, was carelessness on the part of the two men who were killed, * * * the workmen, while cleaning the boiler, had unknowingly loosened too many steam jets, and the vapor, pouring so strongly against the dust pans, caused the explosion."

This explanation impressed us so profoundly that we were constrained to appeal to the steel company for a few more details. Our request for information elicited the following reply signed by the secretary of the company:

"We beg to advise you that it is the policy of this company never to give out any information relating to our work. We regret that we cannot make any exception in this case."

It is needless to say that this broadgage attitude is thoroughly respectable and highly conservative. It indicates acute business acumen. No danger of suffering from adverse criticism when no one outside is qualified to form an opinion as to who is responsible. No opportunity for others to profit by the mistakes that have been made.

The Midvalve Steel Company is heartily to be congratulated upon the broad mindedness of its managers.

The National Association of Stationary Engineers

POWER yields to nobody in its interest in and good wishes for the National Association of Stationary Engineers. Its senior editor has been a member for a quarter of a century and three more of its editors are members in good standing. We have published and lauded its achievements, taken part in its committee and research work, and urged its advantages to those who were eligible for membership. A canvass of the members would reveal the fact that a large percentage of them got their first knowledge of the association from POWER and that the impression produced by what they read was favorable to the organization.

We have not hesitated, however, when the occasion seemed to demand it, to criticize the methods followed and to suggest how the means and activities of the association could be employed to better advantage. The expensive annual convention is a case in point. The bulk of the income of the national organization, upward of twenty thousand dollars, is disbursed every year in mileage that some two hundred delegates may travel across the country, elect a new set of officers, and decide where the next convention is to be held. Add to this mileage the hotel and other expenses of the delegates and a fair compensation for four days' time of two hundred high-grade men and we challenge any advocate of the continuance of the system to show anything that any recent convention has done which has been worth the expenditure to the membership.

Bill Banger, in his impressions of the last convention, brought this point out forcibly and we are glad to see that our views are shared by the president of the Wisconsin State Association, who in a forceful address, which is being presented at all the State conventions, demonstrates the small amount of benefit acruing to the membership from the big annual convention and urges smaller representation through State associations and the use of the fund now spent in transporting a large number of men to great distances for no useful end to educational and other beneficial purposes

John E. Carroll, of carbonic-acid-engine fame, was arrested in Boston, Mass., on June 23, charged with having used the United States mails in a scheme to defraud.

Inquiries of General Interest

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it.

Speed of Rope Drive

What are the velocities at which different sizes of rope should run to transmit one horsepower?

R. E. A.

For transmitting one horsepower, ropes should run at speeds as follows:

Diameter.	Speed.
½ inch	1000 feet per minute.
¾ inch	450 feet per minute.
1 inch	250 feet per minute.
1½ inch	115 feet per minute.
2 inch	75 feet per minute.

This table is based on the assumption that the working stress shall not exceed 200 pounds for a cross-sectional area of 1 square inch, which is about one-thirtieth of the strength of the rope and allows a wide margin for wear.

Volumes of Air Compressed

How many volumes of free air must be compressed to obtain any desired pressure?

H. D. W.

As many volumes as 14.7 is contained times in the number denoting the absolute pressure to which the air is compressed.

Hard and Soft Patches

What is the difference between a hard and a soft patch on a boiler, and should a patch be put on the inside or outside of the shell?

C. W. A.

Soft patches are bolted to the sheet and are usually made tight with red lead or similar packing as calking is impracticable. Such patches are seldom used with high pressures.

Hard patches are riveted to the sheet and made tight by calking. Sometimes hard patches are put on with tap bolts which are screwed into tapped holes in the sheet and riveted. A patch should always be put on the inside as otherwise it will form a sort of a pocket for the collection of scale and sediment.

Temperature and Pressure

If two vessels of the same or different sizes, one half full and the other quarter full of water and heated to the same temperature, will the steam pressure be the same in both? And if so, why?

C. J. M.

If both are heated to the same degree the steam pressure in one will be equal to that in the other, for the pressure of steam always depends on the temperature and not on the amount of water. If the temperature is 212 degrees the pressure in the vessels will be 14.7 pounds per square inch. If the temperature is raised to 338 degrees the pressure will be 115 pounds.

Direction of Rotation

What is meant by the expression "running with the sun" as applied to waterwheels?

It is a term used by millwrights and means to the right or "right handed" as the hands of a watch or clock. Clockwise is a term frequently used to express the same thing.

Density of Water Under Pressure

Is it true that sea water is so dense at great depths that iron will not sink through it to the bottom?

M. M. H.

No! It is not true. Sea water at great depths is under tremendous pressure but being incompressible is no more dense than at the surface and iron will sink as readily at one depth as another as there is the same difference in weight for equal volumes.

Pressure on Safety Valves

I was denied a license the other day because I said that if there were two safety valves on the same boiler, one 2 inches in diameter and the other 3½ inches, the pressure would be the same on each. Please let me know what was wrong in my answer.

A. S.

The pressure *per square inch* is the same against each; but there are more square inches in one case than in the other, so that the total pressure against the 3½-inch valve is about three times as great as that against the 2-inch valve. There was evidently a misunderstanding about what was meant by the pressures being "the same."

Force of Expanding Water

If I confine one cubic foot of water at a temperature of 32 degrees and heat it to 212 degrees, how much pressure will it exert in trying to expand?

P. H. H.

It would exert a pressure equal to that required to compress it from the greater volume to the smaller and as this has never been accomplished it is impossible to tell what the pressure would be.

Diagonal Stays

How is the required cross-sectional area of a diagonal boiler stay determined?

U. S. R.

Multiply the area of a through or direct stay necessary to support the given surface by the length of the diagonal stay and divide the product by the perpendicular distance from the surface supported to the center of the palm of the diagonal stay.

Steam Pump and Injector

What makes a steam pump feed the boilers? Why is it that an injector will not feed a boiler of high pressure when it is hooked to a low-pressure boiler? I have one high-pressure and two low-pressure boilers and my injector won't work on the high pressure because it is hooked to the low-pressure boiler and I use a power pump on the high-pressure boiler.

E. G. W.

The ordinary boiler-feed pump forces water into the boiler from which it takes steam, because the steam piston has a larger area than the water piston, and the steam pressure on one side of the steam piston is not balanced by the water pressure upon the opposite side of the water piston, and it is this unbalanced pressure that drives the pump.

Injectors have a limited range outside of which they will not work. An injector using steam at 100 pounds pressure might force water into a boiler against the pressure of 150 pounds per square inch, while the same injector using steam at 40 pounds pressure might not be able to force water against a pressure of 60 pounds.

To feed a boiler carrying a high pressure with an injector taking steam from a boiler carrying a much lower pressure would require that the injector be especially designed for this work, as exhaust injectors are.

Horsepower of Engine

I have a 10-inch engine with a stroke of 32 inches running 170 revolutions per minute. The boiler pressure is 80 pounds. What is the horsepower of the engine?

J. C. A.

The piston speed is 906 feet per minute, and (neglecting the area of the piston rod) the engine will develop 2.15 indicated horsepower for each pound of mean effective pressure, which if taken at 35 pounds would be 75.25 horsepower.

New Power House Equipment

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news.

Nelson Blowoff Valve

The body of this valve is provided with the inlet *A* and outlet *B* which is controlled by the reciprocating piston *C*. In open position the piston provides a curved port, as shown at *D*. The piston has a V-shaped recess directly over the curved port to retain the packing *E*, and is adjusted by the gland sleeve *F*, which is also provided with similar V-shaped recess. The gland sleeve is carried by the piston *C*, and adjusted by the octagonal nut *G* which is screwed onto the upper end of the piston and is rotated by the double-handled wrench *H*. The wrench cannot be removed from the valve without disassembling, but may be lifted so as to reëngage the octagonal nut *G* in its various positions. The gland sleeve *F* has a flattened portion to engage a similar flattened portion below the thread on the end of the piston *C*, and engages with the guide ribs on the yoke which prevent the rotation of the piston so that the curved port of the piston will register with the inlet connection when in an open position.

The travel of the piston is limited in its open position by the collar *J*, and in its closed position by the lugs at the outlet connection.

Around the gland sleeve, above the inlet connection, a recess is located in the valve body for the packing *K*, which is adjusted by the gland *L*.

When opening or closing the valve, piston, packing, gland sleeve, octagonal nut and wrench travel in unison. The packing *E* in the V-shaped recess passes the inlet connection in opening or closing, but the packing *K* is stationary. The packing *E* is adjusted by the wrench *H* when the valve is in a closed position.

The valve is made in all sizes, flanged and screwed, straightway and angle, and is designed to withstand a working pressure of 250 pounds with full pipe area and bronze fitted to withstand the destructive effect of the blowoff products.

A good feature is that the various parts and adjustments are in full view of the operator at all times.

This valve is manufactured by the Nelson Valve Company, Chestnut Hill, Philadelphia, Penn.

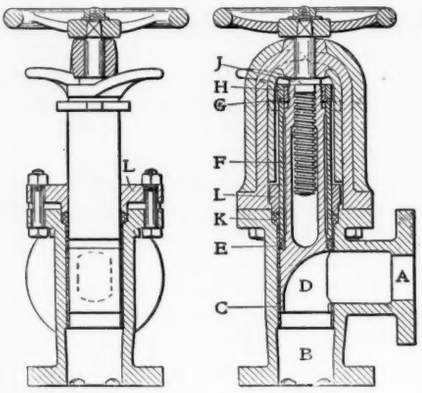


FIG. 1. VALVE OPEN

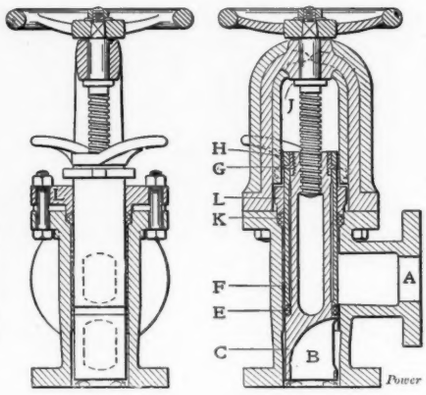


FIG. 2. VALVE CLOSED

The Brosnihan Pipe Wrench

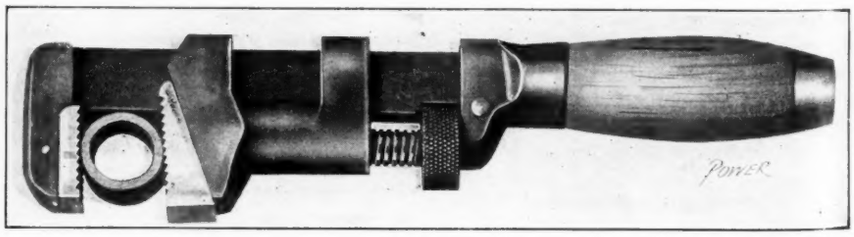
This pipe wrench can be adjusted and operated by one hand, leaving the other free to hold and guide the pipe. A firm and sure grip is obtained by means of wedge and screw attachments.

The movable wedge or sleeve jaw being held against the pipe by a spring, grasps it instantly on the downward movement of the handle bar. It can be set so that it will not crush thin pipe and it can readily be released and removed from the work.

The jaws are made of tool steel, hardened, and tempered in oil, and the bar sleeve and screw are case-hardened. Extra jaws can be procured to replace those worn out, making an old wrench as good as new.

To use the wrench place it on the pipe and turn the thumb screw until the jaws press against the work. Then ease on the handle and turn the screw until the sleeve jaw projects 1/16 to ⅛ inch over the end of the sleeve, and then use as any ordinary wrench. For thin pipe set the wrench so the sleeve jaw, when holding the pipe, will rest on the bar.

This wrench is manufactured by the Brosnihan Wrench Company, 31 Hermon street, Worcester, Mass.



BROSNIHAN PIPE WRENCH

Liberty Four Valve Strainer

This strainer is made in two types, one with top drive, Fig. 1; the other with side drive, Fig. 2. The side drive is used on vacuum work where air leakage is not permissible when cleaning the strainer. The screw of the side drive passes up through the lower valve and is surrounded by a tube so that there can be no leakage past the threads of the screw where it passes through the lower valve. For pressure work and service in which a small leakage of air can be neglected, the top drive is generally employed.

The four-valve strainer, as the name implies, has four valves, two valves per set, one of which is hollow and in which is placed the strainer basket. When in use, the water is always passing through one of the strainer baskets, entering at the top, the other one being, if necessary, cut out for cleaning purposes. The body of the strainer is made of one casting.

In the condition shown in the illustrations the water is passing through the right-hand strainer, the left-hand strainer being raised and ready to be removed for cleaning, which can readily be done by

removing the cover and slipping the strainer over the valve stem. When the dirt has been removed, the basket and

FIG. 1. TOP DRIVE

the cover are replaced, and the basket is ready for service. The four-valve strainer is designed for use where the water does not contain very large quantities of foreign matter and is recommended only for such cases.

FIG. 2. SIDE DRIVE

The strainer is manufactured by the Liberty Manufacturing Company, 6705 Susquehanna street, Pittsburg, Penn.

Foster Fixed-focus Pyrometer

The chief argument against the usual forms of radiation pyrometers is that they require expert knowledge in handling them. The design of the Foster fixed-focus pyrometer overcomes this restriction. It requires no intricate manipulation or adjustment in its use.

The manner in which the instrument is used is shown in Fig. 1. The operator is observing the temperature of a boiler furnace and exploring the temperature distribution in order to determine if it is high enough and sufficiently uniform. The instrument indicates instantly on the dial the temperature of the hot body at which the tube is pointed. It is not necessary to open the furnace doors to take the temperature if a peep hole 1½ inches in diameter is available.

The construction of the instrument is shown in Fig. 2, which is a diagram of the receiving tube. At the front end of the tube there is a diaphragm *E F* and at the opposite end a concave mirror *C*. The line *A B* represents the surface of any hot body and the dotted lines indicate how this will radiate heat to the mirror *C*. This mirror has one focus at the aperture *E F* and the other at the sensitive device *D*. This sensitive device is the junction of a small thermocouple. The mirror *C* concentrates upon *D* the heat image of the aperture *E F* filled with the radiant heat from the hot bodies and this heat image raises the temperature of the themocouple, giving rise to an electromotive force. Connection is made to an indicating millivoltmeter by means of a flexible cable and the indications of this millivoltmeter are calibrated to read in degrees of temperature direct.

FIG. 1. THE FOSTER FIXED-FOCUS PYROMETER IN USE

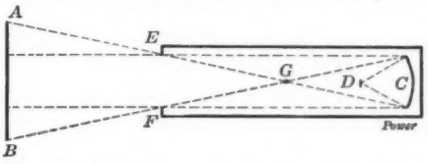


FIG. 2. DIAGRAM OF THE RECEIVING TUBE

The relative position of the mirror *C*, the sensitive device *D* and the aperture *E F* are all fixed so that the focusing is done once for all and is never changed in use.

In order that the aperture *E F* may be entirely filled with radiant heat from the hot body *A B* it is necessary that the tube be brought within a certain maximum working distance. This working distance varies with the size of the hot body and is measured from the apex *G* of the cone *G A B*. The position of this apex is shown on the outside of the receiving tube by a clamping ring which may be seen in Fig. 1 at the center of the tube.

The rule for the working distance is that the center ring must be within ten times the diameter or smallest dimension of the hot body. Any distance less than this maximum working distance is satisfactory and will not affect the reading. Looking at the diagram in Fig. 2, it will be seen that if the hot body *A B* were brought nearer to *G* the only result would be that the outer edges of it would not be in the measurement as they could only radiate heat to the walls of the tube and these are made nonreflexing.

The instrument is calibrated to give direct temperature reading without corrections.

It was devised by Charles E. Foster and is manufactured by the Taylor Instrument Companies, Rochester, N. Y.

Wisconsin N. A. S. E. State Convention

The tenth annual convention of the Wisconsin State association opened Friday, June 17, with an address of welcome to the delegates by Mayor John C. Voss, and a response by A. B. Balzer, State president, of Sheboygan. About sixty delegates from all parts of the State were present at this session, while additional members of the State body arrived in the city during the afternoon. In his address of welcome Mayor Voss extended a cordial greeting to the visitors and commended them on the purposes for which they met annually, concluding his remarks with an outline of the many beautiful buildings and recreation spots in the city and the advantages to be enjoyed by the residents of "Only One Oshkosh." Mr. Balzer, in his response, outlined briefly the history of the association, telling of its organization in the East 28 years ago and the progress it has made since.

Isaac H. Crawford, who acted as chairman of the opening exercises, then introduced Fred W. Raven, of Chicago, secretary of the National association. Mr. Raven said: "The objects of this association are truly embodied in fraternalism. As the preamble states, the association was organized for this purpose only, and not for the furtherance of strikes or to interfere in any way between its members and their employers in regard to wages. Its meetings are for educational purposes and for the securing of the enactment of engineers' license laws." Short addresses followed by F. H. Turner, of the *Practical Engineer*, and F. B. Fulman, of Muncie, Indiana.

W. A. Converse, of the Dearborn Drug and Chemical Company, gave an interesting talk on "Boiler Feed Water," before the convention Friday evening. The talk was made more interesting by the use of charts, illustrations and chemical apparatus. Mr. Converse gave many demonstrations of much value to the engineers, which if applied to their routine work, would mean a saving of money and incidentally help to work out the idea of conservation of natural resources.

Officers elected for the following year were: A. A. Schroeder, of LaCrosse, president; A. La Budde, of Ashland, vice-president; S. W. Marty, of Oshkosh, secretary; John F. Murphy, of Madison, treasurer; Richard Gaepel, of Milwaukee, conductor; E. S. Wells, of Stevens Point, doorkeeper, and W. Classmann, of Milwaukee, State deputy. The new officers were installed by F. W. Raven, who congratulated them upon the advancement they had made in the association, and complimented the retiring officers on the work they had accomplished during the past year.

A special delegation from Milwaukee attended the picnic at the Power Boat club, which was one of the principal features of the entertainment program. Fishing and dancing were indulged in and a ball game between the Milwaukee and Oshkosh members proved an interesting event, in which the Oshkosh engineers succeeded in winning by a score of 4 to 3. A dinner was served at noon and a bountiful supper was prepared in the evening.

Saturday afternoon the visitors were entertained by George M. Paine, president of the Paine Lumber Company, on his steam yacht "Nia." A trip was made to Winneconne and Lake Butte Des Morts, returning to the Oshkosh Yacht club. Refreshments were served by the host during the course of the ride. On returning to their respective homes all reported one of the most pleasant visits ever enjoyed at a convention city and many valuable ideas were taken away.

The place of next meeting will be decided upon later by the officers. It is understood that La Crosse and Fond du Lac both are contesting strongly for the honor.

Conn. State N. A. S. E. Convention

The fifteenth annual convention of the Connecticut State association of the National Association of Stationary Engineers was held at New Haven, Friday and Saturday, June 24 and 25, with headquarters at the Garde hotel.

At eleven o'clock on Friday morning, a preliminary meeting was called to order by State President George A. Cleveland

Delegates and Visitors at the Connecticut National Association of Stationary Engineers State Convention

in the engineers' hall in the Boardman building. Mr. Cleveland welcomed the delegates and guests and appointed the several committees, after which the meeting adjourned until nine o'clock on Saturday morning.

On Friday evening the convention assembled at the engineers' hall to participate in a social session. The festivities began with a brief address of welcome by Mayor Frank Rice. National President William J. Reynolds spoke earnestly in favor of State associations, and also gave a general outline of the good work of the National Association of Stationary Engineers. Past National President Herbert E. Stone praised the ladies' auxiliary and the life and accident department, and dwelt particularly on the fraternal side of the organization. Edward Maroney's short talk was well received. Joshua O'Leary recited and Jack Armour entertained with songs and stories. Refreshments were served. State President Cleveland was the toastmaster and H. G. Nichols was the pianist.

At the business session on Saturday morning, the principal work was in regard to the securing of a suitable State license law; the delegates voted unanimously for such a law. After several routine matters were disposed of the election of officers took place, resulting as follows: President, Charles H. Ostrander, Meriden No. 1; vice-president, Frank L. Chapman, Norwich No. 6; secretary and treasurer, Henry Vanderbergh, Hartford No. 5; conductor, John H. Sherman, New Haven No. 10; doorkeeper, Thomas Reed, New Haven No. 2; trustees, George P. Thomas, Norwich No. 6; Patrick J. Grace, Bridgeport No. 4; George A. Cleveland, New Haven No. 2. The officers were installed by Past National President Herbert E. Stone, assisted by Thomas P. Burke.

The State association voted to recommend to the national convention as the next State deputy James A. Laudon, Torrington No. 17.

Two new associations were admitted to membership during the past year.

The convention voted to recommend to the national convention in Rochester that Springfield, Mass., be the meeting place for the 1912 national convention.

The next annual meeting will be held in Hartford in June, 1911.

On Friday afternoon the convention took special trolley cars to Tabard Inn, Lighthouse point, where a shore dinner was served. The principal feature of this outing was a baseball match between the engineers and supplymen.

The exhibitors were: Dearborn Drug and Chemical Works; M. T. Davidson Company; Harrison Safety Boiler Works; Quaker City Rubber Company; Lake Erie Boiler Compound Company; General Electric Company; Keystone Lubricating Company; Perfection Grate Company; Paul L. Crowe; The Iron Works Company; Garlock Packing Company; Albany Lubricating Company; C. E. Squires Company; William R. Winn; Hartford Mill Supply Company; *Practical Engineer;* Connecticut Metal Boiler Cleaner Company; Ashton Valve Company; A. W. Harris Oil Company; H. W. Johns-Manville Company; McLeod & Henry Company; Home Rubber Company; Greene, Tweed & Co.; Jenkins Brothers; American Steam Gauge and Valve Manufacturing Company; J. H. Williams & Co.; Birch, Riley & Co.; C. S. Mersick & Co.; Lunkenheimer Company and POWER AND THE ENGINEER.

Excursion of the Combined Associations of Brooklyn

The third annual excursion of the Combined Association of Engineers of the Borough of Brooklyn, N. Y., was held at Cranberry lake, N. J., on Sunday, June 26. Fully fifteen hundred excursionists, comprising the engineers and their families, boarded special trains for the lake, where a most delightful day was spent.

Flywheel Explosion

Shortly after 7 o'clock on Thursday morning, June 23, a flywheel explosion occurred in the shops of the Morgantown & Kingwood Railroad Company at Morgantown, W. Va. Harry Murphy, foreman of the car-repair and wood-working department, was killed.

The engine to which the accident happended was an old simple affair which did not have any governor. It drove a circular saw for cutting up heavy timber.

The regular sawyer was not at the plant on the day of the explosion. Murphy started up the engine and, not being familiar with its control, it is thought that he turned on a full head of steam which caused the unloaded engine to race.

The flywheel was completely demolished. It was 6 feet 8 inches in diameter and 13 inches across the face.

Except for a few holes in the roof and side walls, where the fragments of the wheel penetrated the building, the property damage was small.

PERSONAL

C. T. Anderson has been appointed manager of the Chicago office, 1616 Fisher building, of the C. W. Hunt Company, New York, builders of coal-handling, conveying and hoisting machinery.

W. E. Crist, formerly president and general manager of the Crist Valve Manufacturing Company, is now the general manager of the valve department of the O. M. Edwards Company, of Syracuse, N. Y.

Charles L. H. Wilke, formerly sales manager of the Jeanesville Iron Works Company, has been appointed district manager of the Wheeler Condenser and Engineering Company, with offices at 816 Commonwealth Trust building, Philadelphia, Penn.

C. W. Hunt Company, New York, builders of coal-handling, conveying and hoisting machinery, has opened offices in the State Bank building, Richmond, Va., and also at 607 Rhodes building, Atlanta, Ga., with W. F. Lee, for several years preliminary engineer to the company, in supervision.

Walter H. Derriman, B.Sc., A.C.G.I., A.I.E.E., a well known electrical patent attorney, of London, England, has entered into partnership with the firm of Dicker & Pollak, chartered patent agents, of 37 Furnival street, Holborn, London, E. C., England, and will personally conduct their electrical patent work. The name of the firm has been altered to Dicker, Pollak & Derriman.

The firm of Frazier & Fox, engineers, Cleveland, O., has been dissolved. The business and obligations of the firm have been assumed by J. W. Frazier, who will continue the engineering work under the name of "The J. W. Frazier Company" with offices in the Rockefeller building.

J. H. Fox, the other member of the firm, will be chief engineer for the Pittsburg Plate Glass Company.

NEW PUBLICATIONS

TESTS OF TIMBER BEAMS, by Arthur N. Talbot, issued as Bulletin No. 41 of the Engineering Experiment Station of the University of Illinois, is a detailed report of the tests of a large number of full-size timber bridge stringers. The test beams included new, seasoned, and creosoted wood of several species. The report also gives the results of shear and bending tests on specimens cut from the large beams. Important conclusions concerning strength and other properties of structural timber are given. Copies of Bulletin No. 41 may be obtained gratis on application to W. F. M. Goss, director of the Engineering Experiment Station, University of Illinois, Urbana, Illinois.

A resolution has been introduced in Congress creating a commission to investigate and report upon the advisability of holding an exposition commemorative of the semi-centennial of negro freedom.

An exposition is to be held on Put-in-Bay island during 1913 in commemoration of the one hundredth anniversary of the battle of Lake Erie.

NEW INVENTIONS

Printed copies of patents are frnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

COMPOUND ENGINE. Charles Baden, Hackensack, N. J. 961,094.

TWO-CYCLE GAS ENGINE. Oscar H. Dorer, Irvington, N. J. 961,111.

INTERNAL COMBUSTION ENGINE. William W. Morse, Newark, N. J. 961,152.

STEAM ENGINE. Henry W. Weaver, Hutchinson, Kan. 961,186.

REVERSIBLE STEAM TURBINE. Frank C. Beyerle, San Diego, Cal., assignor of one-half to R. M. Mobius, San Diego, Cal. 961,205.

TWO-STROKE CYCLE MOTOR. Armand Peugeot, Tony Huber, and Henri de Lostalot, Billancourt, France. 961,315.

FLOAT TIDE MILL. Uriah S. Jackson, Ossipee, N. H. 961,410.

EXPLOSIVE ENGINE. Ernest S. Bowen, Geneva, N. Y., assignor of one-half to Walter Lester Fay, Geneva, N. Y. 961,581.

WINDMILL. John A. Swanson, Canton, S. D. 961,658.

INTERNAL COMBUSTION ENGINE. John W. Bradley, Seattle, Wash., assignor of one-half to Jacob E. Zickrick, Seattle, Wash. 961,677.

WINDMILL. Lee C. Matthews, San Francisco, Cal. 961,705.

BOILERS AND FURNACES

OIL BURNER. John C. Banks, Chillicothe, Tex. 961,386.

STEAM GENERATOR. Robert J. Galbraith, Albany, Oreg. 961,490.

STEAM GENERATOR. George M. L. Moore-Irvine, Newry, Ireland. 961,516.

FURNACE GRATE. Herman A. Poppenhusen, Evanston, Ill. 961,528.

POWER PLANT AUXILIARIES AND APPLIANCES

WATER PURIFIER AND CLARIFIER. John E. Angell, St. Louis, Mo. 961,091.

COOLING TOWER. Edwin Burhorn, Hoboken, N. J. 961,100.

WATER METER. Ernest E. Gamon, Newark, N. J. 961,116.

MECHANICAL JOINT FOR VACUUM TUBES. Daniel McFarlan Moore, Newark, N. J., assignor to Moore Electrical Company, New York, N. Y., a Corporation of New York. 961,151.

GOVERNING MECHANISM FOR EXPLOSIVE ENGINES. Peter Paulson, Marshfield, Wis. 961,156.

SWIVEL HOSE COUPLING. James Shotwell, Watsonville, Cal. 961,170.

VALVE DEVICE. John Slorach, Cleveland, Johannesburg, Transvaal. 961,173.

VALVE MECHANISM. Charles W. Everson, Brooklyn, N. Y., and George F. D. Trask, Orange, N. J., assignors to said George F. D. Trask. 961,220.

NIPPLE AND CLAMP FOR PIPES. Charles E. Maxfield, Cleveland, Ohio, assignor of two-fifths to Egbert F. Hammond, Cleveland, Ohio. 961,247.

CARBURETER. Ernest N. Broderick, Detroit, Mich. 961,284.

STEAM REGULATING VALVE. William F Kiesel, Jr., Altoona, Penn. 961,300.

REVERSING GEAR. Victor E. Randall, Battle Creek, Mich. 961,316.

TURBINE BLADE. Henry H. Watt, Chicago, Ill. 961,328.

PISTON PACKING. Charles E. Ross, Columbus, Ohio. 961,373.

CARBURETER. Thomas Leggett Sturtevant, Quincy, and Thomas Joseph Sturtevant, Wellesley, Mass., assignors to Sturtevant Mill Company, a Corporation of Maine. 961,423.

VALVE. Theodore Shade, Sacramento, Cal., assignor to Lightning Valve and Dredge Company, Stockton, Cal. 961,466.

CARBURETER. William C. Carter, St. Louis, Mo. 961,481.

SHAFT PACKING. Chester Comstock, Ridgewood, N. J. 961,484.

SHAFT BEARING. George C. Hicks, Jr., Connersville, Ind., assignor to the P. H. & F. M. Roots Company, Connersville, Ind. 961,496.

OILING DEVICE. Robert T. Horlick, Chicago, Ill., assignor of one-half to Edward T. Horlick, Chicago, Ill. 961,497.

VALVE. George G. Little, Gulfport, Miss. 961,505.

BOILER BRACE. Charles Neblett, Bellevue, Ky. 961,522.

VALVE FOR CARBURETERS AND OTHER APPARATUS. Arthur E. England, Boston, Mass., assignor of one-half to James A. Yantis, Malden, Mass., and one-half to Frank P. Woodbury and Willis Du Bois Pulver, Salem, N. H. 961,590.

GATE VALVE. Adalbert W. Fischer, Philadelphia, Penn., assignor to Schutte & Koerting Company, Philadelphia, Penn., a Corporation of Pennsylvania. 961,594.

OSCILLATING PISTON PUMP. Michael Keller, Eureka, Utah. 961,618.

IGNITION MAGNETO MECHANISM FOR AIR STARTED INTERNAL COMBUSTION ENGINES. Charles E. Sargent, Corliss, Wis., assignor to Wisconsin Engine Company, Corliss, Wis., a Corporation of Wisconsin. 961,648.

ROTARY BEARING FOR SUSPENDED SHAFTS. Frederick R. Barnheisel, Chicago, Ill. 961,670.

METHOD OF BURNING POWDERED FUEL. Henry R. Barnhurst, Allentown, Penn., assignor of one-half to Henry Gregory Barnhurst, Catasauqua, Penn. 961,672.

SAFETY VALVE. Louis Schutte, Philadelphia, Penn.; Guarante Trust & Safe Deposit Co., and Mary D. Schutte, executors of said Louis Schutte, deceased, assignors to Schutte & Koerting Company, Philadelphia, Penn., a Corporation of Pennsylvania. 961,735.

COMBINED CHECK AND GATE VALVE. John H. Stickel, Handy Harrisville Station, Penn. 961,738.

ELECTRICAL INVENTIONS AND APPLICATIONS

ELECTRIC FUSE. Anthony J. Smith, New York, N. Y., assignor of one-third to William J. Smith, New York, N. Y. 961,175.

ELECTRICAL BLOCK TRAIN CONTROL SYSTEM. John B. Tonnar, Clayton, Wash. 961,177.

ALLOY FOR ELECTRICAL RESISTANCES. Wilbur B. Driver, East Orange, N. J. 961,217.

ELECTRIC CUT OUT. Thomas E. Murray, New York, N. Y. 961,308.

SYSTEM OF ELECTRICAL DISTRIBUTION. Granville E. Palmer, Boston, Mass. 961,313.

TIME CONTROLLED ELECTRIC SWITCH. Fred M. Tottingham, New York, N. Y., assignor of one-half to Elie J. Moneuse, Sheepshead Bay Station, Brooklyn, N. Y. 961,558.

INSULATOR. William Louis Reusch, Yorkton, Saskatchewan, Canada. 961,646.

ELECTRIC SWITCH. Harry C. Grant, Bayonne, N. J. 961,693.

ARC LAMP. James C. Piper, Indianapolis, Ind. 961,733.

INCANDESCENT-LAMP SYSTEM. Yasuke Kawasaki, Vancouver, British Columbia, Canada. 962,435.

VAPOR ELECTRIC APPARATUS. John T. H. Dempster, Schenectady, N. Y., assignor to General Electric Company, a Corporation of New York. 962,497.

ELECTRIC HAMMER. Burton M. Dutton, Richmond, Va., assignor of one-half to William H. Oxenham, Richmond, Va. 962,499.

RECEPTACLE OR SOCKET FOR ELECTRIC LAMPS. Walter S. Ryan, New York, N. Y., assignor of three-fourths to Louis Hengerer, New York, N. Y. 962,589.

APPARATUS FOR ELECTROPLATING PIPES, ETC. Daniel Hayes Murphy, New Castle, Penn. 962,655.

DYNAMO ELECTRIC MACHINE. Miles Walker, Manchester, England, assignor to Westinghouse Electric and Manufacturing Company, a Corporation of Pennsylvania. 962,683.

ARC LAMP. Thomas J. Anderson, Houston, Tex., assignor to the Anderson-Lacy Electric Headlight Company, Houston, Tex., a Corporation of Texas. 962,692.

ELECTRIC-MEASURING INSTRUMENT. Robert D. Hickok, Atlanta, Ga. 962,759.

ELECTRIC HEATING UNIT. Herbert M. Smith, Pittsfield, Mass., assignor to General Electric Company, a Corporation of New York. 962,793.

MOTOR CONTROL. Hugo Heymann, Berlin, Germany, assignor to General Electric Company, a Corporation of New York. 962,835.

STARTING DEVICE FOR ELECTRIC MOTORS. David H. Plank and Alfred C. Finney, Schenectady, N. Y., assignors to General Electric Company, a Corporation of New York. 962,856.

STORAGE BATTERY. Charles Frederick Washburn, New London, Conn. 962,870.

THERMO ELECTRIC FURNACE REGULATOR. James H. Bobbitt, Harvard, Neb. 962,884.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., W. W. Freeman, Brooklyn, N. Y.; sec., T. C. Martin, 33 West Thirty-ninth St., New York.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U .S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railway, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., L. B. Stillwell; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August 2-5, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, 606 Main St., Peoria, Ill. Next convention, Denver, Colo., September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.